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PATHFINDERS IN MEDICINE

BY THE SAME AUTHOR

FOOTPRINTS OF HIPPOCRATES

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IV. GOITER CHRONOLOGY
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UNIFORM WITH PATHFINDERS IN MEDICINE

Pathfinders in Medicine

BY

VICTOR ROBINSON, M.D.

Editor of the Pagel-Sudhoff Handbook of the History of Medicine

To Dr. I. Fischer,
With the compliments of
Victor Robinson

NEW YORK
MEDICAL LIFE PRESS
1929

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To

MAX NEUBURGER

Professor of the History of Medicine in the University of Vienna

WITH A PUPIL'S ESTEEM, WITH A FRIEND'S AFFECTION

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FOREWORD TO THE SECOND EDITION

The first edition consisted of fifteen chapters: Galen, Aretæus, Paracelsus, Servetus, Vesalius, Paré, Scheele, Cavendish, Hunter, Jenner, Laennec, Simpson, Semmelweis, Schleiden-Schwann, Darwin. The second edition consists of thirty chapters, the following fifteen having been added: Rhazes, Descartes, Malpighi, Berzelius, Guthrie, Purkyně, Henle, Duchenne, Bernard, Hebra, Blackwell, Pasteur, Koch, Metchnikoff, Pavloff.

Cordial thanks are due the foremost of American medical historiographers, Lieutenant-Colonel Fielding H. Garrison of the Surgeon-General's Library for the circumspection with which he read the Henle manuscript, in spite of the inroads made upon his private leisure, and for his courtesy in offering many helpful suggestions; to Henle's daughter, son and grandson—Emma Henle (Heidelberg), Adolf Henle (Dortmund) and Alfred Rühl (Charlottenburg) for contributing the Henle illustrations and letters hitherto unpublished; to Robert Koch's niece, Mathilde Koch, for the illustrations which were published for the first time in the Koch essay; to the surgeon who has made autograph-hunting a fine art, Dr. Erik Waller (Lidköping, Sweden) for the holograph letter, portraits and Swedish documents relating to Scheele and Berzelius; to Samuel Guthrie's grandson, Thaddeus Samuel Chamberlin (Chicago) for Guthrie data; to Alice Stone Blackwell (Dorchester, Mass.) and Frances Stone (New York) for the portraits of the Blackwells; to Purkyně's grandson, Professor Cyril Purkyně (Prague) and Professors M. Novikov (Prague), F. K. Studnička (Brünn) and Paul J. Hanzlik (San Francisco) for Purkyně data, and particularly to Dr. Henry J. John (Cleveland). Emilie Recht was helpful in many ways, especially in consulting the original sources.

During that spiritual journey in which we all partake—and the more perilous the voyage, the more imperative that we embark—the author entered many temples and knelt before many shrines: the idols of his early days have fallen from their pedestals, and the Truth lay reachless beyond the abandoned altars. The author's belief in a Beneficent Being disappeared painlessly, for it was succeeded by an ardent faith in Humanity—which in turn succumbed when he found that human history is as cruel as Nature. The vulgarities of patriotism, the corruption of officials in high places, the degeneracy of the Daughters of the American Revolution, the Sacco-Vanzetti case, the censorship of books and plays, the legislation against science, and the hypocritical farce of Prohibition, have destroyed his last vestige of hope for democracy. On the other hand, the radicals and freethinkers he has met, and whom he once regarded as the harbingers of a better era have proved equally impossible. Having cherished many creeds, the author now finds himself without any, and at last realizes the wisdom of Lessing's words: "I hate all people who want to found sects. It is not error but sects—it is not error but sectarian error, nay, and even sectarian truth, which causes the unhappiness of mankind."

The essays which make up this book were published from 1909 to 1929—and these twenty intervening years have carried the author from the period of youth to the threshold of middle life. We live in the renaissance of machinery, but in the decadence of the human spirit. Across the deepening twilight of the dying faiths we seek an answer on a new horizon, and the only reply is the million-voiced roar of the Motor. Even before our era, John Addington Symonds asked, "What is left for us modern men? We cannot be Greek now," and he answered, "Hasheesh, I think: Hasheesh of one form or another." The author's particular form of hasheesh has been medical history. Interest in the History of Medicine has persisted, for it is the greatest of stories—the record of man's conflict with credulity.

May 1, 1929 V. R.

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(130–200 A. D.)

GALEN

I have long since finished, divine Cæsar, the abridgment of the books of Galen, which you charged me to make, during our residence in the nearer Gaul. You deigned to express your satisfaction on the subject, and you enjoined upon me, at the same time, another work—that of reducing to a single volume, all that the most illustrious physicians have taught, of utility, on the Healing Art. I have, therefore, resolved to gratify you according to my abilities. I shall be careful to omit nothing of what Galen has said, because he is, of all those who have written on these matters, the one who has treated his subjects with most clearness, reason, and method. Moreover he shows himself the faithful interpreter of the principles and sentiments of Hippocrates.

ORIBASIUS: *to Julian the Apostate.*

PATHFINDERS IN MEDICINE

I

GALEN

We may judge a man by the company he keeps, by the books he reads, perhaps even by the clothes he wears, but not by the woman he marries. Take Nikon, for instance: a quiet man, a mathematician and a philosopher, asking for nothing but to be left in peace among his parchments—but what a wife he had! Such a bawling virago, biting her maids and tormenting her husband, that all who saw her declared Xantippe a paragon of patience by comparison. And Xantippe had reason for her lip-labor, because Socrates made no money, while Nikon was a wealthy man.

But Nikon had one consolation: his son, Galenus. It is true, at times the lad exhibited a hasty temper, but above all he was studious. Galen hated his noisy mother, but loved his thoughtful father. Nikon fed the boy on a stimulating diet that has never been equaled: Greek philosophy. Geologists tell us that the earth has cooled—so has the human mind. The ancient Greeks will forever remain the intellectual wonders of the world. It was not sufficient to tell young Epicurus that all things came from Chaos, for he then asked, "And whence came Chaos?" When a Greek philosopher gazed at the sea or the sky, he uttered epigrams which will be repeated by the lips of time till the waters go dry and the firmament passes away.

By the time Galen was seventeen years of age he knew the stoic, platonic, peripatetic and epicurean systems, and had already composed a commentary on the dialectics of Chrysippus; he resolved to consecrate himself to the pursuit of knowledge, and when he read how a citizen of Megara risked his life in order to listen to Socrates, he hoped that some day he too would be able to sacrifice something for the sake of philosophy, or at least be able to exclaim with Anaxagoras, "To philosophy I owe my worldly ruin and my soul's prosperity."

But one night Æsculapius appeared to Nikon and warned him that his son must devote himself to medicine. It seems that a mathematician may be a mystic, for Nikon believed in dreams; the son likewise accepted the omen, and henceforth Hippocrates meant even more to him than Plato; Clarissimus Galenus thus fulfilled Aristotle's maxim, "The philosopher should end with medicine—the physician commence with philosophy."

In Pergamus, Asia Minor, where the family of Nikon lived, was a school of medicine, and a library that made Alexandria envious. Indeed, the second Ptolemy was ignoble enough to decree that no more papyrus should be exported from Egypt in order to keep Pergamus from adding more manuscripts to its archives, but the Pergamene people took splendid revenge by inventing parchment.

But Pergamus was chiefly celebrated for its shrine to the healing god. According to Lucian, Jupiter was complaining that his altars were deserted since Apollo set up his oracle at Delphi, and Æsculapius opened shop at Pergamus. At Epidarus and Cos the Asklepions were equally successful—in spite of the satires of Aristophanes. Always craftier than the populace, the priests built the temples of Æsculapius in spots favored by nature—in the midst of a health-giving forest, by the side of a medicinal spring, on the brow of a lofty hill. The sight alone often served to bring the first smile of hope to the weary invalid—and patients who seemed too sick were not permitted to approach the sacred precincts. All the glories of

Greek art were there—lovely Venus and laughing Bacchus, Zeus serene on his golden throne, and Æsculapius sorrowing for the ills of mankind. Fountains played in the shaded groves, and shelter-seats were arranged in semi-circles of pure marble. And when hidden music floated over the southern flowers—the mingling of rhythm and perfume, the marriage of fragrance and melody—many sufferers raised their heads to repeat the prophecy of the Delphic sibyl: Oh, Æsculapius, thou art born to be the world's great joy.

Only after he had undergone a course in dietetics and hygiene, did the gates of the temple open for the pilgrim; but that night he lay at the foot of the statue of Æsculapius, awaiting and expecting a cure. At times, when the snores of the patient were echoed back by the marble walls, the priests would steal noiselessly forth and bind a broken limb or anoint a wounded organ. Of course every temple rang with tales of wonderful cures. Who ever heard of a shrine—though it be built above the bones of an ass—that did not report miracles, and exhibit abandoned crutches and votive offerings as proof? A mortal like Socrates refused remuneration for his teachings, but Æsculapius demanded silver and gold for his services—at least so the priests claimed. Indeed, on one occasion, the god so far forgot himself as to say aloud to a patient, "Thou art healed, now pay the fee."

But an Asklepion afforded excellent opportunities to the right man, and during an epidemic of carbuncles, when ulceration laid bare the structures beneath, Galen studied anatomy. But what did this intelligent and well-trained youth think of the wonder-tales of divine cures which were bruited about? He believed these stories implicitly, for credulity, like tuberculosis, is universal.

In his twentieth year Galen learnt the limits of the physicians' power: they could not save his father. He then left Pergamus, to pursue his studies in various cities, for the conquests of Alexander had dispersed Greek culture far and wide. Galen journeyed to Smyrna, where he became a pupil of Pelops, who was an authority on muscles; at Corinth he studied under the anatomist Numisianus; he traveled through Asia Minor and Palestine, everywhere absorbing knowledge and performing autopsies with enthusiasm.

But Alexandria called to him; in those days the Hellenic capital of Egypt was the chief seat of Hellenic learning; the seeds from the tree of Hippocratism had fallen and blossomed in Pharaoh's land. In Alexandria Galen found himself engulfed in a vortex; all currents of medical thought circled around and whirled on into the eddy of dialectic subtility; dozens of sects argued violently; all schools pressed their claims in eloquent debate: dogmatists, methodists, pneumatists, eclectics. Some swore by Hippocrates; others by Herophilus; others by Erasistratus; Diocles, Praxagoras, Callimachus, Dioscorides, all had their adherents. Clinical observations were neglected for experiments in rhetoric; it was enough to make one think of the tombstone-epitaph that Pliny loved to quote: "He died by reason of the confusion of the doctors."

Galen was not the man to allow himself to be long perplexed by the wrangling of rival physicians. Physically buoyant and healthy, gifted with genius, contemptuous of others and with boundless confidence in himself, he selected from each sect what appealed to him, rejected the rest, and built up a system of his own. Fortunately he was wise enough to take as his model the incomparable Hippocrates. Galen's ability was vast and his industry unwearied; he soon learned all that teachers could impart. Before he completed his teens he began to write on medical topics, and during his journeys treatise after treatise fell from his prolific pen. Galen was absent from his native place for nine years; at about the age of twenty-eight he returned, and the bronzed and cultured traveler was welcomed by the high priest of Pergamus who appointed him physician to the gladiators.

The occurrence of the gladiatorial combats was evidence that

APOLLO

The ever-occupied and myriad-sided Olympian, god of innumerable realms, including the Muses and Medicine. The Hippocratic Oath begins with the words, "I swear by Apollo the Physician."

ÆSCULAPIUS

The specific god of medicine, son of Apollo and the nymph Coronis, educated by the centaur Chiron, accused by Pluto of depopulating Hades, slain by the thunderbolt of the angry Zeus who feared his skill in healing would make the children of earth immortal. Temples to Æsculapius arose throughout Greece, on mountain heights and near the healing springs.

HYGIEIA

The goddess of health, daughter of Æsculapius and Epione; she is usually seen wearing the Greek chiton and feeding the sacred snake, symbol of renovation.

HIPPOCRATES

One of the many traditional portraits of the Father of Medicine.

Hellas had fallen: the stern games in which strong men hewed each other with spears; the bloody battles by torchlight; the strange animals, captured from African forests, charging against their tormentors; the fantastic fighting between dwarfs and women; the whole excited assembly rising and shouting as rivers of blood flowed through arena and amphitheater; pain and fear below, and lust and luxury above,—*Ave, Cæsar; morituri te salutant!*—in this manner the Romans, but not the Greeks, amused themselves.

For four years Galen tended the wounded gladiators; in this employment he acquired an extensive knowledge of surgery, and his methods of treatment proved unusually successful. But Galen was not content with Pergamus; he wanted Rome. A province in lesser Asia was insufficient for a medicus who felt himself greater than all other physicians; as well have expected Aristotle—Nature's private secretary, as Eusebius called him—to hide his talents at Stageira. To show off his superior attainments, Clarissimus Galenus needed the center of the world's stage; aware of his power, and consumed with ambition, he hungered and thirsted for the streets of the wicked but mighty capital.

Rome, the great plagiarist, never had a medicine of her own. Rome was notorious for her hatred of doctors. Pliny, author of the dictum that a doctor is the only person not punished for murder, has left it on record that for six hundred years the Romans knew no physicians. But gradually Greek physicians settled in Rome, and the men of Mars seemed to grow accustomed to the extravagance. But the tradition remained, and Pliny wrote, "The dignity of the Roman does not permit him to make a profession of medicine, and the few Romans who begin to study it are venal renegades to the Greeks." Pliny's contemporary, Valerius Martial, composed medical epigrams for the delight of his sturdy countrymen:

Languid I lay, and thou camest O Symmachus, quickly to see me;
Quickly thou camest and with thee a hundred medical students;
The hundred pawed me all over with hands congealed by the north wind;
Ague before I had none, but now, by Apollo, I have it!

In the year 162 a stranger entered Rome—it was Galen. In the midst of the barbers, bath-keepers, midwives, magicians, plaster-spreaders, ointment-makers, bleeders, cuppers, abortionists, makers of love-philters, venders of amulets, had come a disciple of Hippocrates. Specialism was rife in Rome, as we learn from Martial's irony: "Cascellius extracts and repairs bad teeth; you, Hyginus, cauterize ingrowing eyelashes; Fannius cures a relaxed uvula without cutting; Eros removes brand-marks from slaves; Hermes is a very Podalirius for ruptures."

But Galen was a specialist in all branches, and panted only for an opportunity to diagnose the disease of a senator or prætor—and thus win fame and fortune at a stroke. Among his first patients was Eudemus, a peripatetic philosopher of renown. The wife of the consul Bœthus was sick; Galen cured her, and received the consul's friendship, four hundred gold pieces, and a reputation. A noble Roman matron, the wife of Justus, could not sleep; her case baffled all the physicians; but Galen traced her insomnia to her love for the dancer Pylades.

Galen did not make diagnoses merely by feeling the pulse; he studied not only the disease, but the patient, and he took considerable pleasure in proclaiming that much of his success was due to his ability to take advantage of an opportunity: he would observe what was in a vessel that a servant was carrying out, or what was contained in the jar that stood near the invalid. Evidently he was the spiritual ancestor of that physician who berated his patient for eating horse-flesh, and when questioned by his assistant how he knew this to be the case, answered, "I saw the harness under the bed."

It was not long before Galen became the most distinguished practitioner in Rome. He was called the wonder-worker—Paradoxopœus. Galen did not accept the title with blushing cheek and downcast eye. The conceit which enabled him to say, "Whoever seeks fame need only become familiar with all that I have achieved," was thick enough to protect him from embarrassment at any compliment. Not only did the boastful Galen praise himself unceasingly, but he mocked all his rivals with a scornful tongue; he called them fools and asses, and told them they did not know anything.

"I have done as much to medicine," wrote Galen, "as Trajan did to the Roman Empire, in making bridges and roads throughout Italy. It is I alone that have pointed out the true method of treating diseases: it must be confessed that Hippocrates had already chalked out the same road, but as the first discoverer, he has not gone so far as we could wish; his writings are defective in order, in the necessary distinctions; his knowledge in some subjects is not sufficiently extensive; he is often obscure after the manner of the ancients, in order to be concise; he opened the road, but I have rendered it passable." Some figures of antiquity appear hardly human: the white-robed Plato, broad of brow and ever-thoughtful, slowly pacing down the shadeful aisles of the Academic Grove, seems more like a personification of philosophy than a man, but Galenus had qualities like our next-door neighbors.

The leaders of Roman society requested Galen to establish a course of lectures on Anatomy and Physiology, which he gladly did, illustrating them with experiments on goats and pigs. The élite crowded to these demonstrations, and were pleased to be informed that they possessed more common sense than the physicians.

At Alexandria Galen had been fortunate enough to witness two human skeletons, and he strongly urged all who intended to study osteology to go to Africa. But at his lectures a human skeleton was never exhibited, for the good reason that there was not a single one in all Rome. So bloodthirsty were the Romans of this period, that neither the populace nor the fashionables could enjoy a holiday unless contending ranks of gladiators were butchered for their sport, but they recoiled with horror at the notion of permitting a scientist to examine the murdered corpse. In this respect the Romans resembled a small and persecuted sect—despised by Galen—which was just rising into prominence at this time, but which was later to overrun all Europe and forbid dissection on the ground that it was impious to mutilate the image of God, and yet showed no hesitancy in crushing the bones or burning the bodies of thousands of heretics. The psychology of inconsistency is tragically interesting.

For four years Galen resided at Rome, writing many of the works which have perpetuated his name: he worked as hard as he bragged. "There are many physicians," declared Galen, "like the athletes, who would like to win prizes in the Olympic games, and yet will not take the pains necessary to gain them. For they are loud in their praises of Hippocrates, and place him in the highest rank among physicians; yet never think of imitating him themselves. It is certainly no small advantage on our side to live at the present day, and to have received from our ancestors the arts already brought to such a degree of perfection; and it would seem an easy thing for us, after learning in a short time everything that Hippocrates discovered by many years of labor, to employ the rest of our lives in investigating what still remains unknown."

In the year 166 it was practically certain that he was to be admitted into the imperial court. Yet it was at this very time that he secretly left the capital. Galen claimed he so acted because he feared his envious rivals had decided to assassinate him. But the truth seems to be that he left Rome because an epidemic had come. Rome, with its usual intrigues, was bad enough; but Rome, with an eastern pestilence added, was too much for the Pergamene physician. Galen was too selfish to die for others. In those days there were real plagues: this one spread over Europe, infected everything in its wide path, and remained for fifteen years, slaughtering men and animals by the million, terrorizing the world into a mad-house and a morgue. Æsculapius must have been sleeping.

Galen set his face toward home, studying all the way; from the copper mines of Cyprus he collected medicinal ores, Balm of Gilead at Palestine, asphalt from the Dead Sea, and many

ARISTOTLE
Bas-relief of the founder of biology.

drugs in Phœnicia. At last he stood once more in the fertile valley of Pergamus; he remained there about a year. But the Greeks and Romans had a habit of recalling their famous sons almost as soon as they were out of sight. Half the illustrious men of Athens and Rome were exiled and invited to return. The emperor Marcus Aurelius summoned Galen to his side. Marcus Aurelius was at Aquileia, preparing to wage war against the Marcomanni, though he would much have preferred to be in his study, writing his *Meditations*. When Galen arrived in the camp, the flesh-fed plague was thinning the army, and the emperor and his soldiers fled back to Rome. On setting out a second time against the enemy, Marcus Aurelius desired Galen to be his companion, but the physician informed his ruler that in a dream Æsculapius had warned him to remain at Rome and attend the emperor's children. And sure enough, little Commodus soon became sick, and Galen performed the doubtful service of saving a creature that became one of the most infamous of the hideous Roman emperors. But Faustina, the mother of the monster, was pleased, and she thanked Galen heartily, and crooned into the ear of her child that one day he would wear the purple.

Upon the decease of Demetrius, Galen was appointed court physician, but he had considerable time for scientific work, as his chief duty consisted in preparing for Marcus Aurelius a costly treacle, a supposed antidote against all poisons. In the days of imperial Rome such precautions were not superfluous, but what the mixture really contained we cannot say, as its principal constituents were immersed in a flood of polypharmacy.

In 175 Marcus Aurelius succeeded in subduing the fierce Marcomanni, and returned to the capital. Of course a triumphant emperor must be feasted, and the Romans were champion gluttons with extraordinary alimentary canals, but the scholarly Aurelius was really a transplanted Greek whose ordinary stomach gave way under the endless courses. Poor Marcus needed all his stoic philosophy to keep him from groaning, and he sent for several physicians. A physician's function is to administer medicines, and they did so, but their drugs did not avail. Galen was sent for, but we must allow him to relate the incident in his characteristic style:

> Hereupon I was summoned also to spend the night in the palace, a messenger coming to fetch me, by order of the emperor, just as the lamps were being lighted. Three physicians had seen him in the morning and at the eighth hour, and two had felt his pulse, whilst to all did it appear the beginning of an attack. I, however, remained silent; then the emperor, perceiving me, asked why I had not, like the others, felt his pulse. I replied: Two have already done this, and from their experiences upon the journey with thee are better able to judge of its present condition. As I said this he called on me to feel him, and as the pulse, taking into consideration the age and constitution of the patient, seemed to me inconsistent with an attack of fever, I declared that none was to be feared, but that the stomach was overloaded with nourishment which had been coated with phlegm. This diagnosis called forth his praise and he thrice repeated: Yes, that is it, it is exactly as thou sayest; I feel that cold food is disagreeing with me. He then asked me what was to be done. I answered him frankly that if another than he had been the patient, I should, following my custom, have given him wine with pepper. With sovereigns like thyself, however, I said, physicians are in the habit of employing the least drastic remedies, therefore it must suffice to apply wool saturated with warm spikenard upon the abdomen. The emperor replied that warm ointment on purple wool was his usual remedy for pain in the stomach, and called Peitholaus to apply it while he bade me depart. No sooner had I gone than he demanded Sabine wine, threw pepper into it and drank, after which he said to Peitholaus that now at last he had a physician and a courageous one, repeating that he had tried many but that I was the first of physicians and the only philosopher among them.

Of all the old dietitians, and it must be remembered that the ancient physicians paid much attention to food—Athenæus being enthusiastic enough to remark that a good physician ought to be a good cook—Galen was by far the greatest.

There is indeed little in the realm of dietetics, from pistachio nuts to the flesh of buck-goats, that was not considered by him; and the diet fitting to the different seasons, the diet of persons actively employed, the diet of travelers, the regimen for infants and for the aged, repletion and easy methods to produce vomiting, are only a few of the dietetical topics which he discussed sagaciously. Of course he gave directions for reducing obesity, but if he had any success in this respect, he knew an elegant art that is lost to the moderns.

He stood high as an hygienist; he was the man to consult on questions of baths and gymnastics; his work among the gladiators made him a leading authority on exercise. He was the founder of climatic cures, and ever since then, wealthy women have been asking, "Doctor, what disease must I have in order to go to Ostend?"

On fevers, and everything connected with febrile affections, whether ephemeral, bilious, putrid, hectic, tertian, quatran or quotidian, Galen was the chief fountain-head of wisdom. Regarding the plague, however, he had little to say; perhaps his conscience was pricked, for he had only to open Thucydides to see how Grecian physicians perished at their posts during the epidemic at Athens.

Such homely subjects as corns and callosities, burns and blisters, coughing and sneezing, a bruised nail, headache, toothache, baldness, bleeding of the nose, loss of eyelashes, wrinkles and freckles, Galen treated with sense and skill. He wrote good descriptions of jaundice, colic, dropsy, asthma, coryza, dysentery; and on such diverse maladies as diseases of the teeth, ulcers, wounds of nerves, scirrhus, herpes, gangrene, erysipelas and emphysema, he was the chief authority of classic antiquity.

As far as we know he was the only one of the ancients who wrote a treatise on feigned diseases; he was the first to treat of aneurism; he wrote seventeen chapters on the pulse; he was the first who realized the importance of predisposition to disease; he based his prognosis upon diagnosis; he paid much attention to secretions and excretions; it is claimed that his ophthalmic collyria could be consulted with advantage by present-day oculists; he knew that phthisis was infectious, saying, "It is a matter of experience that those who sleep in the same bed with consumptives fall into consumption, also those who live long with them, eat and drink with them, or wear their clothes and linen."

In obstetrics Galen did not distinguish himself; the great obstetrician and gynæcologist of antiquity was Soranus of Ephesus. Galen spoke of the two uterine cavities, the right for the male fetus, and the left for the female—which causes us to suspect that he never examined a woman's womb. Galen, however, did make some meritorious investigations into the causes of sterility. As a surgeon, Galen did not equal his contemporary, Antyllus.

As a writer on materia medica he cannot rank with Dioscorides, but he was second to him alone. It has been calculated that Galen's Materia Medica consisted of 540 plants, 180 animal, and 100 mineral substances.

He was a prolific writer on pharmacy; he wrote so much about plasters that if he had been an ordinary worker he would not have had time for anything else. The preparation of medicines by physical means is still called galenical pharmacy, but it is not clear why he has been honored with the title of Father of Pharmacy.

Reaching the outposts of the knowledge of Herophilus and Erasistratus, and advancing indisputably beyond them, Galen stood without a rival as an anatomist. He was practically the creator of morphology, and it must be remembered that unlike the older Alexandrian masters, he had no opportunity to explore the human body; his scalpel was confined chiefly to apes, but he used all animals he could obtain, from elephants to mice. The Father of Anatomy never dissected a man. Galen must have been seized with envy when he read in Celsus that in the days of the Ptolemies not only did the Alexandrian scientists have all the corpses they needed, but that they re-

GALEN

From an old manuscript in the Imperial Library of Vienna. There are no authentic portraits of Galen.

GALEN

Another imaginary portrait of the physician of Pergamus.

ceived criminals "for dissection alive, and contemplated, even while they breathed, those parts which nature had before concealed."

To-day, whoever speaks of anatomy, pays tribute to Galen; the *platysma myoides,* says the modern anatomist, but this muscle was first named and described by the Pergamene physician. The frontalis muscle, the popliteus, the two muscles of the eyelids, the six muscles of the eyeball, the muscles of the spine, the muscles of each lateral cartilage of the nose, the maxillary group of muscles, with many muscles of the head and neck, both extremities and the body proper, were comprised in the Galenian myology, and in many instances the names which he suggested have been retained unto the present time.

He divided the vertebræ into cervical, dorsal and lumbar, and gave a correct account of the number and the situation of each. He named the bones and sutures of the cranium, and knew the squamous, styloid, mastoid and petrous portions of the temporal bones; the sphenoid, the ethmoid, the malar, the maxillary and nasal bones were familiar to him. In these descriptions Galen made few errors. The moderns have made little change in his osteology.

Angiology was the weakest point in the Galenic structure of anatomy, but even here he built better than his contemporaries, for in opposition to the prevailing views of the age, he proved that the arteries convey, not air, but blood. He was the first to describe, with some correctness, the aorta, the jugular vein, and the three coats of arteries. We are not in the habit of thinking that the capillary connection between the arteries and veins was known in antiquity, but let us not be startled at anything that we find among the Greeks: Hippocrates used the word *circulation,* and Galen knew anastomosis. In *De Usu Partium* Galen wrote: "The arteries and veins anastomose with each other throughout the whole body, and exchange with each other blood and spirits by certain invisible and exceedingly minute passages."

Galen's contributions to neurology were noteworthy. He knew that the brain is the central organ of the nervous system, and that the spinal cord is an offshoot, but he made the mistake of thinking that the nerves of sensation arise in the former, and the nerves of motion originate in the latter. His method of demonstrating the brain was a masterpiece of minuteness, and he traced several of the cranial and spinal nerves with accuracy. "If the spinal cord," wrote Galen, "be divided lengthwise from above downward by a straight section through the median line, none of the nerves going to the intercostal muscles are paralyzed, either on one side or the other, nor any of those going to the loins or the lower limbs." We agree with him that the motor fibers do not cross the cord, but we wait to hear what he will say as to the effect on sensibility; but he was silent, and seventeen centuries passed before the answer came that a longitudinal section of the cord in the median line, while it does not interfere with motion, destroys sensibility. The nervous system was his favorite field of investigation, and the fruit was rich enough for him to earn the title of Founder of Experimental Physiology.

His description of the thoracic contents is good—except that he thinks the heart is not a muscle because it acts continuously, while all muscles alternate their work with rest—and his account of the abdominal organs and the urinary apparatus was explicit and precise.

We have yet to mention that he discovered or was the first to describe the tendon Achilles, the lachrymal ducts and glands, the ductus Botalli, foramen ovale, the corpus callosum, septum lucidum, corpora quadrigemina.

Galen was an explorer, but the lands that lie beyond the seas did not interest him like the unknown regions of the body; he did not crave to discover distant kingdoms, for locked within the cranium he found ample treasures; he blazed no path in primitive forests, but all through its winding labyrinths he followed the trigeminal nerve, slowly discovering the secrets that were strewn along its tortuous way. Galen adored the mechanism of the body; he was filled with wonder at the perfection of its parts. He claimed that in writing anatomy he was really celebrating the Creator; again and again the great Pagan physician breaks forth into pæans of praise: "In writing these books I compose a true and real hymn to that awful Being who made us all; and, in my opinion, true religion consists not so much in costly sacrifices and fragrant perfumes offered upon his altars, as a thorough conviction of his unerring wisdom, his resistless power, and his all diffusive goodness."

An extract like the following illustrates Galen's interest and delight in the body: "In the inner cavity of the larynx there is a structure of peculiar formation, which we have already shown to be the principal organ of the voice. It resembles the mouthpiece of a reed-pipe, especially when seen either from above or from below. Instead, however, of comparing the glottis with the tongue of reed instruments, it would be more appropriate to compare them with the glottis. For the works of Nature are both earlier in time, and more perfect in construction, than those of art; and, as the glottis is the work of Nature, while the reed-pipe is the production of art, it is possible that the latter might have been made in imitation of the glottis by some clever artist, able to understand and copy the structure of natural objects."

His teleological proclivities are seen in passages such as these: "In my view there is nothing in the body useless or inactive; but all parts are arranged to perform their offices together, and have been endowed by the Creator with specific powers."

We regret that we cannot share Galen's convictions in these respects. Man is compelled to perform the lowest and highest functions in life with the same organ, and was it nice on Nature's part to place the womb between the bladder and the rectum? St. Augustine was no physiologist, but he was vilely correct when he said that we are born between urine and feces.

Teleology was indeed a rotten spot in Galenism. Wise Anaxagoras had said that adaptation to function disproves teleology, but Plato and Aristotle believed in design in nature, and Galen followed them, and erected the most elaborate teleological system ever known. Hippocrates approached questions with an open mind, but Galen came with his dogmas, and sought to make his observations fit into the mold of preconceived notions. His practical work was invaluable, but most of his theoretical digressions are tedious and worthless. He wrote volumes of nonsensical assumptions, and seemed to suffer from an Asiatic imagination. It often happened that he was prevented from interpreting his results correctly because of his predilection for *a priori* reasoning.

Hippocrates left medicine free, but Galen fettered it with hypotheses. Hippocrates related his failures, and used to say, "I do not know," but Galen always imitated an oracle. "Science and Faith," said Hippocrates, "are two things: the first begets knowledge, the second ignorance"; but Galen sought to mix the observations of Hippocrates with the metaphysics of Plato. Galen abhorred doubt; his mind craved for finalities. Galen admired Euclid's method of proving things, and he tried to make medicine as exact a science as geometry; it is difficult to decide which was the greater—the absurdity or the audacity of the attempt. In his system everything was explained; everything was catalogued and tabulated. He answered all questions, he solved all problems. There seemed nothing left for others to do except to say, Amen. And so it was. Galen was the last of the Greeks, and when he spoke no more, the voice of antiquity was hushed.

Already in the second century there were signs of the coming darkness; soon the imperial city succumbed to invading barbarians, and in the ashes of Rome was buried all that was left of Greece. Then came the deluge. Clouded by Christianity, the world lay for centuries in the abyss of irrationalism. Monks crept over Europe, and in their trail walked mental stagnation. Medicine became magic, and science was turned into sorcery. Supernaturalism displaced the natural, and no fact was believed unless it was supported by a miracle. Sometimes an Arabian physician would stir a smoldering Greek ember into flame, but it was intellectual night in the dominions of the Nazarene.

During the fifteen hundred years that the world was too indolent to think for itself, Galen was its undisputed authority. His dogmatism was well suited for the general sloth. He was regarded as infallible; age after age rolled by, and in Europe, Africa and Asia he remained the unquestioned dictator. From his grave he ruled continents and centuries. He had only one rival—the Stagyrite. "If Galen and Aristotle are of one mind on a subject," wrote Rhazes, "then of course their opinion is true. When they differ, however, it is extremely difficult to decide which opinion to accept." So we see that the scholars of the Dark Ages followed Galen and Aristotle blindly, and never caught the Greek spirit of free inquiry.

Light did not shine on earth again, until the passion for Greece so inflamed the hearts of men, that on the abandoned altars of Hellas, awakening Europe found burning the torch of unfettered speculation. This was the death-knell of the Dark Ages, and when the clarion calls of Doubt went ringing throughout the lands, mediævalism was transformed into modernity; there was a new dispensation, and new reckonings and re-adjustments. It was a Revolution that mankind has termed the Renaissance. Truth was once more saluted, and in the re-birth of the intellect, independent thought again came to human brains. What happened in art and literature and in general science, is common knowledge and is taught to every school-child, but medical science likewise had its resurrection. A young Flemish anatomist, who plied his scalpel enthusiastically, declared that Galen had made mistakes. The old generation was aghast at the blasphemy, but the world was marching on, and from his inviolate throne, at last fell the physician of Pergamus. But his worth was measured in the impartial balance of history, and the verdict was that Galen was the Prince of Physicians—but not infallible.

ARETÆUS

Whatever the final judgment may be, one thing stands out as certain—after Hippocrates, no single Greek author has equaled Aretæus, and no work in the entire literature so nearly approaches to the true spirit of Hippocratism, both in description of disease and in therapeutic principles, as the work of the Cappadocian.

NEUBURGER: *History of Medicine.*

Aretæus is one of the most original and eloquent writers of antiquity. Starting with a thorough acquaintance with the science of his day, taking Hippocrates as his model, and repudiating all futile speculations, he details the simple results of his own experience, in a systematic treatise of eight books on the history and treatment of acute and chronic diseases, and in a manner so striking and appropriate as rarely to have been excelled.

WATSON: *Ancient Medicine.*

It is a fact of the highest interest that Aretæus recognized the murmur of heart disease. And in connection with it we should note that he does not speak of it as an uncommon or striking symptom, one which he had heard on some rare occasion, in some peculiar case. Had this been so, we may rest assured that so careful and conscientious an observer would have so stated. But he includes it among the common symptoms, such as palpitation, vertigo, fainting, pulse failure, etc. And in the same way we may assure ourselves that the murmur of which he speaks was elicited by the application of the ear to the chest. . . . Aretæus is the only one of the ancient writers, so far as I know, who auscultated the heart.

CORDELL: *Aretæus the Cappadocian.*

II

ARETÆUS

There was once a Greek who was possessed by a prejudice against Cappadocia, for in the *Anthology* we find this couplet:

> A viper bit a Cappadocian's hide;
> But 'twas the viper, not the man, that died.

Nevertheless, one of the prime glories of Greek medicine was a Cappadocian, and one of the chief gaps in medical history is our lack of knowledge concerning Aretæus. Clio has ever been more solicitous of the destroyers, than of the healers, of men. As far as the age of Aretæus is concerned, we have the consolation of knowing that he lived either in the first, second or third century. One reason for this uncertainty is that Aretæus quoted no author except Hippocrates; and no ancients quoted him except Aëtius and Paulus Ægineta, and as both of these writers lived considerably after the time of Aretæus, their reference to him furnishes no clew as to his period. He is also mentioned in the *Euporista,* formerly attributed to Dioscorides. If it were indeed the work of Dioscorides, it would practically solve the problem, as it is almost universally admitted that Dioscorides flourished in the first century. But it is now agreed that *Euporista* is not the composition of Dioscorides, but the work of a later age. According to some authorities, the circumstance that neither Galen nor Aretæus mentions the other, proves they were contemporaries.

It is quite certain that he lived in Alexandria, as he makes numerous references to the habits and therapeutics of the Egyptians; it is also probable that he resided in Italy, as he is familiar with the various brands of Italian wine: Fundan and

Falernian, Signine and Surrentine. But all the biographic data that we know with certainty, can be expressed in one short sentence: Aretæus, a Greek physician of a Roman province in Asia Minor, described diseases in admirable Ionic.

The ever-falling dust of time has almost covered him over, yet it cannot make the name of Aretæus as if it had not been, for Aretæus reared unto himself a monument more enduring than brass—what say you, Quintus Horatius Flaccus? His seven-arched structure was as follows: I, On the Causes and Symptoms of Acute and Chronic Diseases; II, On the Therapeutics of the Same; III, Fevers; IV, Surgery; V, Prophylaxis; VI, Gynecology; VII, Pharmacy. The dome has fallen and the base has disappeared—only portions of the first and second of these works being extant—but enough remains to demonstrate that Aretæus was one of the greatest of ancient physicians.

It is a delight to read Aretæus: he is not superstitious: his mind is not befuddled with outlandish theories: he is clear, rational and scientific; he does not indulge in any of those mystical speculations which disfigure the pages of so many of his successors. Moreover he is a stylist. No doubt the strangest passage Aretæus ever wrote was his fantastic account of the uterus: "In the middle of the flanks of women lies the womb, a female viscus, closely resembling an animal, for it is moved of itself hither and thither in the flanks, also upwards in a direct line to below the cartilage of the thorax; and also obliquely to the right or the left either to the liver or spleen; and it likewise is subject to prolapsus downwards, and in a word, is altogether erratic. It delights in fragrant smells, and advances towards them; and, it has an aversion to fetid smells, and flees from them: and, on the whole the womb is like an animal within an animal."

No medical author surpasses Aretæus in his vivid portrayal of disease. When he describes consumption, we must not read the symptoms twice to make the diagnosis. We hear the hoarse chronic cough, the clearing of the throat, the blood and pus spat up; we notice the sweats, the pallor, the cadaverous aspect; we see the bony fingers, the thickened joints, the curved nails, the sharp and slender nose, and the prominent Adam's apple; we see the narrow chest, the lips drawn over the teeth, the muscles of the arm gone, the ribs sticking through the skin, the shoulder-blades projecting like wings of birds, and the eyes hollow and brilliant.

His descriptions of tetanus, epilepsy, hysteria and asthma have been especially praised, but his picture of satyriasis is as powerful as any: "Satyrs, priests of Bacchus, in the paintings and statues, have the phallus erect, as the symbol of the divine performance. It is also a form of disease, in which the patient has erection of the genital organ, the appellation of satyriasis being derived from its resemblance to the figure of the god. It is an unrestrainable impulse to connection; but neither are they at all relieved by these embraces, nor is the tentigo soothed by many and repeated acts of sexual intercourse. Spasms of all the nerves, and tension of all the tendons, groins, and perineum, inflammation and pain of the genital parts, redness of countenance, and a dewy moisture. Wrapped up in silent sorrow, they are stupid, as if grievously afflicted with their calamity. But if the affection overcome the patient's sense of shame, he will lose all restraint of tongue as regards obscenity, and likewise all restraint in regard to the open performance of the act. Raving with his obscene imagination, he cannot contain himself; tormented with thirst, he vomits much phlegm, and the foam sits on his lips as in a lascivious goat, and he has a smell like that animal." Strangely enough, the author of the above had no knowledge of nymphomania, and even denied its existence. Yet he lived after Valeria Messallina!

Among other disorders which he treats in an interesting manner are: migraine, jaundice, elephantiasis, leukorrhea, hemoptysis, diarrhea, aortitis, cephalalgia, angina, gonorrhea (which he misunderstood), dropsy, dysentery, apoplexy, phrenitis, cachexia, pneumonia.

In his writings we find for the first time an account of diphtheria. The description is well-done except as to the etiology.

There were giants in those days, but no compound microscopes, and Aretæus knew not the Klebs-Loeffler bacillus.

He is the first European who wrote a systematic account of diabetes. He correctly called it a species of dropsy, and paints with realistic strokes the patient's fiery thirst, his imperative desire to pass water, his dry mouth and parched skin; it is a wonderful malady, he says, a melting down of the flesh into urine.

According to Francis Adams—not the unhappy poet who sang the songs of the army of night, and slew himself in the morning of life—but the careful Greek and Latin scholar of the same name who was very familiar with the writings of the fathers of medicine, Aretæus was "the first medical author who alludes to contagion in unequivocal terms."

The fourth book of Paulus Ægineta begins as follows: "Well, in my opinion, did Aretæus the Cappadocian say, that the power of remedies ought to be greater than those of diseases; and that for this reason elephantiasis is incurable, because it is impossible to find a medicine more powerful than it. For if cancer, which is, as it were, an elephantiasis in a particular part, is ranked among the incurable diseases by Hippocrates himself, how much more is not elephantiasis incurable, which is, as it were, a cancer of the whole body?"

Aretæus seems to have understood the direction of the bloodflow in the veins; if so, he knew more than the physicians of subsequent centuries. He was probably the first to use the trephine in epilepsy. He likewise had knowledge of tracheotomy. One of his greatest claims to our consideration is his practice of physical diagnosis. Cordell has pointed out that Aretæus employed inspection, palpation, percussion and auscultation.

He distinguished between the paralyses of motion and of sensation, and knew that injuries to the brain produce paralysis on the opposite side. He divided mental disturbances into mania, melancholia, and settled insanity—not a bad classification.

He described lead colic, and other disturbances due to lead poisoning. In obstruction of the urethra by vesical calculus, he

FRANCIS ADAMS OF BANCHORY

Editor and Translator of Hippocrates, Aretæus, Paulus Ægineta. Bust in the University of Aberdeen.

employed the catheter. He removed stone by incising below the scrotum, and cutting inward to the neck of the bladder until there was an escape of urine and calculi. He deserves credit for his efforts to found pathology upon an anatomical basis.

He had few queer notions. It is true, in conformity with the custom of his age, he was too fond of venesection, but he always warned against excess of bloodletting, claiming it was better to err on the side of chariness. He believed castor was a remedy in all diseases of the nerves, and that white hellebore would vanquish any case of gout. For this we must not blame him severely, for there is scarcely a practitioner who has not at least a couple of old standbys by which he swears.

An idea of the nicety of his observations may be gained from a random passage; in discussing methods of procuring sleep he writes: "Gentle rubbing of the feet with oil, patting of the head, and particularly stroking of the temples and ears is an effectual means; for by the stroking of their ears and temples wild beasts are overcome, so as to cease from their anger and fury. But whatever is familiar to anyone is to him provocative of sleep. Thus, to the sailor, repose in a boat, and being carried about on the sea, the sound of the beach, the murmur of the waves, the boom of the winds, and the scent of the sea and the ship. But to the musician the accustomed notes of his flute in stillness; or playing on the harp or lyre, or the exercise of musical children with song. To a teacher, intercourse with the tattle of children. Different persons are soothed to sleep by different means."

Here is a bit of psychology which every medical man will endorse: "This is a mighty wonder, that in hemorrhage from the lungs, which is particularly dangerous, patients do not despair, even when near their end. The insensibility of the lungs to pain appears to me to be the cause of this; for pain even when slight makes one fear death. In most cases pain is more dreadful than pernicious, whereas the absence of it, even in serious illness, is unaccompanied by fear of death and is more dangerous than dreadful."

Pliny was the prince of credulity and swallowed every fable whole, but Aretæus' caution and skepticism may be sensed from these remarks on the treatment of epilepsy: "It is told, that the brain of a vulture, and the heart of a raw cormorant, and the domestic weasel, when eaten, remove the disease; but I have never tried these things. However, I have seen persons holding a cup below the wound of a man recently slaughtered, and drinking a draught of the blood! O the present, the mighty necessity, which compels one to remedy the evil by such a wicked abomination! And whether even they recovered by this means no one could tell me for certain. There is another story of the liver of a man having been eaten. However, I leave these things to be described by those who would bear to try such means."

There is a vague foreshadowing of endocrinology in this passage: "For it is the semen, when possessed of vitality, which makes us to be men, hot, well braced in limbs, hairy, well voiced, spirited, strong to think and to act, as the characteristics of men prove. For when the semen is not possessed of its vitality, persons become shriveled, have a sharp tone of voice, lose their hair and their beard, and become effeminate, as the characteristics of eunuchs prove."

There is another sentence which we wish to quote, as it will arouse a response from every physician who has been called at the last moment or when there was no hope for recovery: "If you give a medicine at the height of the dyspnea, or when death is at hand, you may be blamed for the patient's death by the vulgar." What a world of reserve and dignity is in this simple remark! The shoulders of Aretæus the Cappadocian were broad enough to wear becomingly the mantle of Hippocrates.

Twenty centuries ago Aretæus knew the knack of driving a point home by a good story. Wishing to illustrate that the gout may intermit, he relates that a person subject to gout won the race in the Olympic games during the interval of the disease. And he closes his chapter on melancholy thus: "A story is told that a certain person, incurably affected, fell in love with a girl;

and when the physicians could bring him no relief, love cured him. But I think that he was originally in love, and that he was dejected and spiritless from being unsuccessful with the girl, and appeared to the common people to be melancholic. He then did not know that it was love; but when he imparted the love to the girl, he ceased from his dejection, and dispelled his passion and sorrow; and with joy he awoke from his lowness of spirits, and he became restored to understanding, love being his physician."

Aretæus shows himself a true physician by his concern and sympathy for the patient, in small matters and great: "Inunctions are more agreeable and efficacious than fomentations; for an ointment does not run down and stain the bed clothes—a thing very disagreeable to the patient—but it adheres, and being by the heat of the body, is absorbed. Thus its effects are persistent, whereas liquid preparations run off."

Elsewhere occurs this noble phrase, rarely equaled and never bettered: "When he can render no further aid, the physician alone can still mourn as a man with his incurable patient: this is the physician's sad lot."

Some authors call their work a "confession"; this is hardly necessary, as all writing is autobiographical. Write, and in spite of your best efforts at concealment, your feelings, passions, prejudices, abilities, failings, sympathies, will become apparent; where you least expect it, you will give yourself most away; your true self will lurk between the lines, and it will peep from the pages.

We are confident that from the excerpts here given, the reader has already formed a high opinion of Aretæus. If ever a man cast credit on the art and science of healing, it was the lofty-souled Cappadocian. He was a disciple who not only followed in the footsteps, but caught the spirit of the immortal Father of Medicine. Aretæus should not be a forgotten physician, for no one better than he could repeat with decorum, the Hippocratic Oath:

With purity and with holiness I will pass my life and practice my art. Into whatever houses I enter, I will go into them for the benefit of the sick, and will abstain from every voluntary act of mischief and corruption; and, further, from the seduction of females and males, of freemen and slaves. Whatever, in connection with my professional practice, or not in connection with it, I see or hear, I will not divulge, as reckoning that all things should be kept secret. While I continue to keep this oath inviolate, may it be granted to me to enjoy life and the practice of my art, respected by all men at all times. But should I trespass and violate this oath, may the reverse be my lot.

(860–932)

RHAZES

In the science of medicine, the Arabians have been deservedly applauded. The names of Mesua and Geber, of Rhazes and Avicenna, are ranked with the Grecian masters; in the city of Bagdad, eight hundred and sixty physicians were licensed to exercise their lucrative profession: in Spain, the life of the Catholic princes was intrusted to the skill of the Saracens, and the school of Salerno, their legitimate offspring, revived in Italy and Europe the precepts of the healing art.

GIBBON: *History of Rome.*

What a noble people were the Arabs! We are indebted to them for much knowledge and for many inventions of great utility; and we should have still more to thank them for were we fully aware of the benefits we have derived from them. What a pity that their works should be suffered to molder into dust, without being made available! What a shame that those acquainted with this rich language should meet with so little encouragement! . . . Had I still twenty years to live, and could hope for an abundant supply of Arabic works, I would learn Arabic.

BECKMANN: *History of Inventions.*

Rhazes was a man of rare attainments who linked the knowledge of his age to the achievements of the past, a tireless writer of immense productiveness and versatility, an inspired teacher—but his also was a more precious gift than erudition, the power to read in the book of nature itself, the clinical insight which ever sees something fresh at the bedside and assures to each case comprehension and treatment according to its individuality. Herein—not on account of his book-learning in which he was equaled or excelled by many of his successors, but as a clinician—he stands high above all the Arabic, possibly above all mediæval physicians, although he never entirely succeeded in emerging from the shadow of Galenism.

NEUBURGER: *History of Medicine.*

III

RHAZES

In sinuous lines, one after one, they came: long caravans of camels, laden not with merchandise but with Greek manuscripts, crossing the desert, bound for Bagdad. Silent and docile creatures, burdened with immortal parchments, but never wondering why Hippocrates and Aristotle and Galen were loaded on the dromedary's hump to be carried across alien sands. . . .

The torch of Hellas had flickered low, and the human mind was lost in darkness. It was mediævalism, and science was in exile. Observation was blind, but the ears of credulity lengthened. Experiments were not performed, but miracles were expected. Supernaturalism had stifled reason. Fanaticism had triumphed over philosophy: the heel of St. Paul was on the neck of Archimedes. When Bishop Cyril's mob dragged from her chariot the beautiful and learned Hypatia, and she was stripped naked and pulled through the streets, when the club of Peter the Reader smote her, and the monks scraped the flesh from her bones with shells, Plato's last representative was gone from once-glorious Alexandria. Cyril's sect grew and grew in numbers; the world in which we live was neglected, for the Judgment Day was pronounced to be at hand, and all were concerned only with the world to come. Euclid lay forgotten, for the ecclesiastics desired to know only enough mathematics to enable them to learn the rule by which the date of Easter could be computed. The garden in which Theophrastus had founded the science of botany was overrun with weeds and monkish tales, and in the city where Democritus laid the foundation of physical science, theologians gravely argued how many angels could stand on the point of a needle, and whether it was the first or second or third person of the Trinity that created the world. Everywhere the human brain seemed weary of thought, and those evil twins, superstition and persecution, reigned all over Europe.

The ever-deepening ignorance choked the fires that once had burnt at Athens, but a spark fell in the East, brought hither by the hunted Nestorians, and the curious Arabians fanned the dying ember until it blazed anew. The Moslem was then in power, his dominion extending from the Mountains of Gold to the Atlantic Ocean; Memphis and Carthage were his, and from the streets of Cordova to the banks of the Indus the mosques were alive with thanks to Allah. The victorious Saracen laughed at Rome, he wrested Jerusalem from the Christians, and in disdain he sold the Colossus, for old brass, to a Jew.

But the conquering Mohammedans were in turn conquered by the Greek manuscripts. Their bigoted insularity disappeared in veneration of the Hippocratic aphorisms. No longer referring to all Europeans as unbelieving dogs, they pondered over the works of Dioscorides. Athens and Rome now anathematized the pagan thinkers, so Hippocrates and Aristotle and Galen left their homes, and the far-stretching caravans of camels brought the precious parchments to Bagdad. Then Honain, the great translator, was happy, and with loving enthusiasm rendered the Greek classics into the Arabic tongue; when he finished a treatise, he brought his work to the enlightened Caliph Almamon, in whose presence it was carefully weighed, and Honain received for every manuscript-translation its weight in gold.

Never were there translators like the Arabians; considering the Greek texts as of almost Koranic sacredness, they copied, compiled, elucidated, amplified, and commented upon the classics with amazing industry—but never criticized. Bagdad's contact with these manuscripts transformed the Asiatic city into an eastern Athens. The fanatical Moslems became men of science, zealously cultivating geology and astronomy, fostering the early steps of chemistry, establishing the first pharmacies, and enriching materia medica by the addition of such important drugs as camphor, tamarinds, cassia fistula, senna, and nux vomica. Many treatises of the oriental physicians were translated into Latin, and became authorities in the West. The Arabic system of medicine imposed itself upon Europe, and there was a time when Avicenna eclipsed Hippocrates. The Arabian influence lasted until the threshold of modernity, and whoever looks at the elaborate title-page of the first London Pharmacopeia, will find it ornamented with four figures: Hippocrates and Galen, the Greeks; and Mesuë and Avicenna, the Arabs.

But never did the Arabs equal the Greeks, and the sole reason the former loomed so large upon the scientific horizon is because the Europeans were afflicted with such mental sloth that they could absorb nothing but dogma. At the time when the Arabians measured the height of the atmosphere and catalogued the stars, and observed that colchicum was beneficial in gout, the monasteries were buying milk purporting to come from the breasts of the Blessed Virgin.

Yet no better proof is needed that the Arabians were essentially mediævalists and not Hellenes—worshipers of authority and not free investigators—than the naïve remark of one of the earliest and most original members of the Arabian school: "If Galen and Aristotle," said Rhazes, "are of one mind on a subject, then of course their opinion is true. When they differ, however, it is extremely difficult to decide which opinion to accept."

Rhazes, known in the East as Abu Becr Mohammed Ibn Zacariya Ar-Razi, was a Persian, born near Khorazan, perhaps in the middle of the ninth century. The date 860 is usually given as his natal-year, but it is hardly more than a surmise. Had he been a military commander who slaughtered multitudes, instead of a health-bringer, history would have been more concerned with his birthday.

Rhazes turned his attention to medicine only after he had reached middle-age—according to Ibn Khallikan, he was over forty before he began to devote himself to physic. When Rhazes was young, he played the lute and cultivated his voice, but according to Ibn Juljul, "on reaching the age of manhood, he renounced these occupations, saying that music proceeding from between mustachios and a beard had no charms to recommend it." A curious essay might be written on those men who undertook to study medicine late in life, and yet achieved success.

Rhazes' teacher in the healing art was the Jewish physician, At-Tabari, who is frequently quoted by Rhazes, but whose books seem to have disappeared; yet one of At-Tabari's aphorisms, which has come down to us through the ages, should never be forgotten: "An ignorant physician hastens death."

In those days traveling was a part of the medical curriculum, and Rhazes knew Jerusalem, and journeyed through Africa, and saw the lamps of Cordova—but he returned to the minarets of Bagdad, the magic city of the Arabian Nights. An hundred famous physicians contended for the directorship of the hospital of Bagdad, but the favor fell upon Rhazes. He developed into the chief clinician of the Arabian school, his material being so extensive that in recommending a mode of treatment for sciatica—sharp clysters until blood was drawn—he was able to say that he had seen this method successfully tried upon a thousand patients. It was the Golden Age of Arabian Medicine, and Rhazes was its effulgence. Pupils—Andalusian, Mozarab, Persian, Berbek, Hebrew, Egyptian—voyaged from afar to seek the teacher who was esteemed the Galen of the Arabians. What did they hear from the lips of Rhazes, over a thousand years ago, among the date-palms of Bagdad? Listen, as did those turbaned scholars, to a fragment of Rhazes' lecture, *On the Factors which Alienate the Public from the Physician:*

> Among the circumstances which cause the hearts of the people to turn away from the reputable physician is the delusion that the medical man should know everything and should ask no questions.

If he inspects the urine or feels the pulse he is supposed to know what the patient has eaten and what he has been doing. I myself, when I began to practice medicine, had resolved to ask no questions when the urine had been given me, and had been much honored. Later, when it was seen that I had made circumstantial inquiries, my reputation sank.

Another circumstance which brings physicians into contempt is that many diseases are too little removed from the border-line of health and are thus difficult to recognize and cure; others, malignant in themselves, externally appear trivial. When the layman sees that the physician is in doubt concerning his cure he draws it as a certain inference that the physician will understand still less of severer and more extensive illnesses. This is a false analogy. The symptoms of such diseases are less obvious because they are slighter deviations from the normal, and their cure is more difficult because no drastic remedies can be applied, but only those the effect of which is gradually brought about, such as diet, etc. An official of the hospital once complained of difficulty in moving some of his finger joints on account of a small but very hard sore which had for some time resisted the remedies he had applied. He openly reviled the physicians, saying: "If your art does not suffice to cure a small sore on the finger, how can you treat broken ribs and arms?" He then sought treatment from the women and the vulgar.

If it be argued that a malady should not be entrusted to one who may make a mistake, we rejoin: Matters must be entrusted to him who is furtherest from error, who errs most seldom. He who otherwise refuses to employ a physician would resemble him who would not ride a horse nor sleep in a canopied bed because horses stumble and the canopy might fall down—which are rare events.

A physician is sometimes undervalued who takes trouble over an incurable complaint; but the imperfection of the art should be considered, in this respect, unlike other arts, of which men know more than is necessary, while in medicine men have not yet attained to the indispensable and do not possess a remedy for every ill. The fault is therefore with the art, not with the physician.

The public demands that the physician should cure in a moment, like a magician, or that he should at least employ pleasant methods, which is not at all times and in all cases possible; to blame the physician on Nature's account is a great injustice. Thus it is that sorcerers make their fortune, even though they behave iniquitously, and their incompetent work brings them a good livelihood, while the physician must often endure poverty.

The heart of the public is further turned from the capable physician and towards fools because the ignorant sometimes succeed in curing complaints where this has not been done by the most famous physicians. The causes are manifold, luck, opportunity, etc. Sometimes the qualified physician effects an improvement which is not, however, yet visible; the patient is then placed under another doctor who rapidly brings about a cure and obtains the entire credit.

Many a quack is experienced in the treatment of a single complaint, or two, according to his practice, or because he has seen the treatment of an intelligent physician. Ignorant people, therefore, think that he has equal dexterity in everything and entrust themselves to him. It is a great mistake to think that, because he has a genuine remedy for one complaint, he has one for all. I have myself learnt remedies from women and herbalists who had no knowledge of medicine.

Remember that the well-trained physician is often in doubt and may take a long time to find the proper remedy. This occurred even to Galen.

Much of this sounds modern—and occidental. The voices of the past often speak in contemporary tones. We are all children of the same Mother Earth, and from the vocabulary of man the word "foreigner" should be erased.

Over two hundred treatises were written by Rhazes, including that vast undigested encyclopedic mass, the *Continent of Medicine.* Everything known to the medical art was put into these huge folios, but without method or arrangement, or any attention to style. Rhazes left this work in manuscript, perhaps realizing that few could cross this unclassified *Continent.* But using the *Continent* as a basis, he prepared another work, dedicated to the Persian prince, Al-Mansur, and thus known as the *Work to Al-Mansur,* here the presentation being concise and

RHAZES

Enlarged from an old woodcut.

elegant, and the topics so well-arranged that it became one of the most popular of compendiums, and for centuries was used as a text-book in the colleges.

The *Work to Al-Mansur* is divided into ten books: the first of these ten books is on Anatomy and Physiology, the second on Temperaments, the third on Food and Simple Medicines, the fourth on Means of Preserving Health, the fifth on Skin Diseases and Cosmetics, the sixth on Diet of Persons on a Journey, the seventh on Surgery, the eighth on Poisons, the ninth on Treatment of General Diseases, and the tenth on Fevers. The *Work to Al-Mansur* long remained "the great magazine of all the Arabian physick,"—and portions of it were translated by so original a modern as Vesalius—but the essence of these books came from Hellas. The work of Rhazes was built upon Hippocrates and Galen, and upon their commentators, Oribasius, Aëtius, and Paulus Ægineta. Yet throughout the compilation are interspersed many Rhazian observations.

Let us ask questions of Rhazes, as did the students of Bagdad, and hear the replies that are more than ten centuries old. Some have been rendered obsolete by time, but others are still of medical value. In our catechism, we will make use of the references to Rhazes in the Banchory scholar's commentary on Paulus Ægineta, an author to whom Rhazes was under obligation.

Master, how can the perspiration be made fragrant? Eat of the heads of cardui, and in the drink put the seeds of juniper or cassia lignea. Drink aromatic wine, and rub the body with pastils of roses.

What should be done for a person who is intoxicated? Apply vinegar and oil of roses to the head, and camphor and water to the nose. Employ an emetic, and put the hands and feet into cold water. After a long sleep, prescribe a bath.

What is the treatment for a person injured by cold? Lay him in a warm apartment, and with heated hands rub the whole of his body, with the exception of the head, which is to be warmed with hot cloths. Persons having warm bodies are then to lie down in bed beside him; and he is to take a draught containing asafetida, myrrh, pepper and strong wine. When the respiration is fairly restored, he is to take some nourishing food and wine; and is then to be covered up with many blankets and left to sleep. When he awakes, he is to be put into a hot bath, and after remaining for a long time in it, he is to be strongly rubbed when he leaves it with the oil of lilies or narcissus, to which costus, castor, musk and spurge have been added.

What precautions are to be observed in vomiting? Much vomiting hurts the liver, breasts, eyes, and lungs, causing hemoptysis. Before taking an emetic, bind a compress on the forehead, and after emesis, wash the mouth and face with hydromel. Individuals who have long necks, prominent chests, and who are lean, ought to abstain entirely from emetics.

What rules should be observed in imbibing water? A draught of water immediately after eating impairs digestion, but is proper after digestion has taken place. Ice, by congealing the stomach and injuring the nerves, is prejudicial to the health, especially of old persons. Water, cooled in snow, is permissible, but its effects are to be counteracted by a moderate allowance of wine.

What are the directions for reducing obesity? Corpulent persons should abstain from animal food, wine, milk, and all sweet things; let them live upon pot-herbs, and such things as are saltish and sour; they should take purgatives and diuretics, exercise hard, use much friction, and frequently remain long in the bath.

How is emaciation to be treated? By protracted sleep, by food consisting of fat meat and the nutritive legumes, and by wines which are red, thick, and sweet; by gentle friction with oil, and the affusion of tepid water over the body; by bituminous and sulphureous baths, which should be taken only after the food is digested, for if taken too soon, it loads the body with unconcocted chyle, and if had recourse to at any other time, it rather induces emaciation.

What is the treatment for epistaxis? Give a styptic powder containing quicklime, vitriol, galls and red arsenic. Apply snow to the head. In extreme cases, the cautery is necessary.

What are the causes of ileus? Inflammation of the bowels, debility of the expulsive faculty, and indurated feces.

What are some of the precautions to be observed in venesection? Forbid food immediately after bleeding, as the empty veins will absorb the chyle before it is properly digested, which will prove a pabulum of disease. Forbid bleeding when the stomach is loaded with crudities, lest they should be absorbed and carried over the system. In retention of the menses, open the saphena, or apply a cupping-instrument to the ankle. In acute inflammation, abstract blood fully from the opposite part, so as to produce revulsion, but when it is chronic, take the blood from the part affected. In bleeding a person who is intoxicated, apply two bandages about the arm, and have proper attendants to restrain the bleeding which is often difficult in such cases.

What are the remedies for synochus? Bleeding, mild purgatives, acidulated drinks, restricted diet, and complete abstinence from wine. The bath is to be recommended, but it should be delayed until the decline of the fever.

How shall we treat cataract? By couching, extracting, and sucking out the cataract. When it cannot be properly depressed, it must be torn. It may be extracted by opening the lower part of the cornea, and it may be sucked out through a glass tube.

What is the treatment for menorrhagia? Astringent trochisks containing the recrementum ferri; cupping-instruments applied to the breasts; stuffing the vagina with wool smeared with the mixture of frankincense, wild pomegranate-flowers, galls, antimony, acacia, and alum. Epithemes are also to be recommended, and when these do not succeed, pessaries made with escharotics.

What is the cure for love-sickness? Try repeated distractions, fasting, walking, and frequent intoxication.

What medicines are useful in impotence? Among the aphrodisiacs are nettle-seed, elecampane, rape-seed, mint, rocket, cresses and cubebs.

What are the symptoms of a displaced womb? In displacement of the uterus, there is vehement pain with distention of the parts; the woman cannot rise nor sit but with difficulty; the urine is retained and sometimes the feces. Restore the uterus to its position by drawing its mouth in the opposite direction.

What are the causes and treatment of dystocia? Difficult parturition may arise from the mother, the fetus, or the secundines. The head is the only natural presentation. In other cases, the life of the mother or child is endangered, although many living children are born by the feet. When delivery of the head is found difficult, employ ligatures or fillets. When the feet or hands present, restore the position, or if that is impossible, bring down the feet. Warm baths and lubricants are of service.

What is the treatment for abscesses? When there is any hope of producing resolution, scarification is the method of choice. When the pain is violent, use hot and humid applications, with the addition of narcotics. After the abscess has been opened with the knife, desiccative applications are indicated, and not ointments containing wax or oil. Abscesses in the limbs are to be opened by a straight incision, but those about the ankles by a circular, as they are apt to terminate in fistulæ.

What are the contents of an enterocele? An intestinal hernia generally arises from dilatation of the passage which leads from the cavity of the abdomen to the testicle. In ordinary cases, there is no rupture of the peritoneum. The contents of the hernial tumor are intestines or omentum.

How should bones be sawed? Stretch the flesh upwards and downwards, with a piece of cloth, so that it may not come in the way of the teeth of the saw. When it is necessary to saw a rib or bone near any important membrane or organ, use a tabella to protect the soft parts from the saw. When the os brachii, or tibia is diseased, extract it entire, but we must not meddle with the head of the femur or the vertebræ.

What should the surgeon remember about dislocation of the shoulder? Owing to the shallowness of the glenoid cavity and the weakness of the ligaments, the bones at the shoulder are more subject to luxations than those of any other point. When dislocated, the top of the shoulder is sharper than natural, the head of the humerus is felt in the armpit, the arm cannot be brought to the sides without pain, or raised to the head at all. When the accident happens during delivery or in childhood, the arm does not grow to its natural size. The dislocation can occur only downwards.

The great physicians of the past have been aphorists, and the Rhazian adages will never lose their meaning: "Treat an incipient malady with remedies which will not prostrate the strength." "With a learned physician and an obedient patient, sickness soon disappears." "When you can cure by regimen, avoid having recourse to medicine; and when you can effect a cure by means of a simple medicine, avoid employing a compound one." "Truth and certainty in medicine is an unattainable goal; and the healing art, as it is described in books, is far inferior to the practical experience of a skilful and thoughtful physician."

The writings of Rhazes contain ingenious and acute observations on topics ranging all the way from hiccough and purgatives to spinal injury and embryotomy. He knew that the pupil contracts to light, and that the remedy for pediculosis of the eyelids is mercurial ointment. He urged the use of cold water in inflammatory fever, and insisted that fever be treated according to its causation. He taught that jaundice was caused by obstruction of the bile-passages, he knew the perils of miasmata, he realized that the nerves of sensation and of motion may be effected separately. He described an instrument for the removal of foreign bodies from the esophagus, and invented a lead catheter which he preferred on account of its flexibility.

European students of Arabian medicine credit Rhazes with having given a fuller account of curvature of the spine, and of the principles of catheterism, than any other author up to his time; he is further credited with being the first who wrote an entire book on pediatrics, the first who introduced chemical preparations into practice, the first who described spina ventosa, the first who maintained that disorders of the bladder are accompanied by hematuria, and the first who employed certain urethral injections.

The classic exposure of quacks is Rhazes' spirited account, and any sketch of the great Persian would be incomplete without it:

> There are so many little arts used by mountebanks and pretenders to physic, that an entire treatise, had I a mind to write one, would not contain them; but their impudence and daring boldness is equal to the guilt and inward conviction they have of tormenting and putting persons to pain in their last hours, for no reason at all.
>
> Now some of them profess to cure the falling-sickness, and thereupon make an issue in the hinder part of the head, in form of a cross, and pretend to take something out of the opening, which they held all the while in their hands. Others give out, that they can draw snakes or lizards out of their patients' noses, which they seem to perform by putting up a pointed iron probe, with which they wound the nostril, until the blood comes: then they draw out the little artificial animal composed of liver, etc.
>
> Some are confident they can take out the white specks in the eye. Before they apply the instrument to that part, they put in a piece of fine rag into the eye, and taking it out with the instrument, pretend it is drawn immediately from the eye. Some again undertake to suck water out of the ear, which they fill with a tube from their mouth, and hold the other end to the ear; and so spurting the water out of their mouths, pretend it came from the ear. Others pretend to get out worms, which grow in the ear, or roots of the teeth. Others can extract frogs from the under part of the tongue; and by lancing make an incision, into which they clap in the frog, and so take it out.
>
> What shall I say of bones inserted into wounds and ulcers, which, after remaining there for some time, they take out again? Some, when they have taken out a stone from the bladder, persuade their patients, that still there's another left; they do this for this reason, to have it believed, that they have taken out another. Sometimes they probe the bladder, being altogether ignorant and uncertain, whether there be a stone or no. But if they

don't find it, they pretend at least to take out one they have in readiness before, and show that to them.

Sometimes they make an incision in the anus for the piles, and by repeating the operation often bring it to a fistula or an ulcer, when there was neither before. Some say they take phlegm, or a substance like unto glass, out of the penis or other part of the body, by the conveyance of a pipe, which they hold with water in their mouths. Some pretend that they can contract and collect all the floating humors of the body to one place by rubbing it with winter cherries; which causes a burning or inflammation; and then they expect to be rewarded, as if they cure the distemper; and after they have suppled the place with oil, the pain presently goes off.

Some make their patients believe they have swallowed glass; so, taking a feather, which they force down the throat, they throw them into a vomiting, which brings up the stuff they themselves had put in with that very feather. Many things of this nature do they get out, which these impostors with great dexterity have put in, tending many times to the endangering the health of their patients, and often ending in the death of them.

Such counterfeits could not pass with discerning men, but that they did not dream of any fallacies, and made no doubt of the skill of those whom they employed: till at last when they suspect, or rather look more narrowly into their operations, the cheat is discovered. Therefore no wise men ought to trust their lives in their hands, nor take any more of their medicines, which have proved so fatal to many.

The text-books of an age are much alike, and when Rhazes opened his *Division of Diseases* by first enumerating the maladies of the head, gradually descending to those of the feet, he was simply following the prevalent but unscientific fashion. But Rhazes wrote a slender *Treatise on Smallpox and Measles,* and here he followed no one. Before Rhazes, the references to pox were of the vaguest sort, but Rhazes placed this disease on the medical map. His description stands out as unrivaled—the original and still surviving landmark in smallpox. For once, an Arabian touched hands with Hippocrates and Aretæus.

It is not his bulky *Continent,* but his tract on *Smallpox and Measles* which makes Rhazes a pathfinder in medicine.

In the preface, Rhazes informs us how he came to compose this work:

> It happened on a certain night at a meeting in the house of a nobleman, of great goodness and excellence, and very anxious for the explanation and facilitating of useful sciences for the good of mankind, that mention having been made of the smallpox, I then spoke what came into my mind on the subject. Whereupon our host (may God favor men by prolonging the remainder of his life) wished me to compose a suitable, solid, and complete discourse on this disease, because there has not appeared up to the present time either among the ancients or the moderns an accurate and satisfactory account of it. And therefore I composed this treatise, hoping to receive my reward from the Almighty and Glorious God, and awaiting his good pleasure.

Rhazes divided his treatise into fourteen chapters, the first dealing with the causes of the smallpox, and how it comes to pass that hardly any one escapes the disease; the second is an enumeration of those habits of body which are most disposed to the smallpox, and also of the seasons in which the disease is most prevalent; in the third, he discusses the symptoms which indicate the approaching eruption of the smallpox and measles; in the fourth he specifies the articles of the regimen or treatment of the smallpox in general; the fifth deals with the preservation from the smallpox before the symptoms of the disease appear, and the way to hinder the multiplying of the pustules after the appearance of the symptoms; the sixth is concerned with those things which accelerate the pustules of the smallpox and their appearance externally, and which assist nature; the seventh tells of the care to be taken of the eyes, throat, joints, ears, and those parts of which it is necessary to take care upon the appearance of the symptoms of the smallpox; the eighth explains the factors which hasten the ripening of those pustules which can be ripened; the ninth is devoted to the drying of the pustules; the tenth contains the mode of taking away the eschars and dry scabs; the eleventh is a discourse on the method of removing the marks of the smallpox; the twelfth treats of the patient's food in the smallpox; the thirteenth contains prescriptions and directions for regulating the patient's bowels in the smallpox; and the final chapter points out the fatal and mild species of smallpox and measles.

In spite of Rhazes' extensive practice, it is claimed he never amassed wealth because instead of forcing fees from his poor patients—and most patients are poor—he relieved their financial distress from his own pocket—truly a remarkable physician! But Ibn Jujul relates a story that is not to Rhazes' credit:

Rhazes composed a treatise on alchemy—the pitfall of science—and presented it to the same Al-Mansur to whom he had dedicated more serious work. Impressed with its possibilities and promises, Al-Mansur bestowed a thousand dinars upon the author, adding, "I wish you to put in practice what you have laid down in this book."

"That is a task," answered Rhazes, "for the execution of which ample funds are necessary, as also various implements and aromatics of genuine quality; and all this must be done according to the rules of art, so that the whole operation is one of great difficulty."

"All the implements that you require," replied Al-Mansur, "shall be furnished to you, so that you may put in practice the rules contained in your treatise."

Even then Rhazes remained silent, and spoke only to admit the impossibility of performing what his treatise promised.

"I should never have thought," said Al-Mansur, "a philosopher capable of deliberate falsehood in a work represented by him as a scientific treatise, and one which will engage people's hearts in a labor from which they can derive no advantage. I have given you a thousand dinars, but I shall assuredly punish you for committing a deliberate falsehood."

Raising his whip, the prince of Khorasan struck Rhazes on the head, and this blow was held responsible for the formation of the cataract which later afflicted Rhazes. A surgeon came to operate upon him, and Rhazes asked him how many membranes the eye contained. The ophthalmologist did not know, so Rhazes sent him away. When Rhazes became completely blind, his friends urged him to permit the operation, as he might recover his sight, but like a true philosopher, Rhazes responded, "No, for I have seen so much of the world that I am weary of it." So in poverty, neglect and blindness passed away the man whom the modern Mead considered "the greatest physician of the age he lived in."

How frail is an empire compared to a book! Gone is the splendor of the Caliphs, and the once-conquering simitars of the Islams lie low in dust, but the *Treatise on Smallpox and Measles*—translated into Latin and Greek and French and German and English—excites admiration afresh in each succeeding generation. What now remains to remind us of the Moslem's conquest? Neither political power in Europe nor far-stretching armies anywhere, but whenever we turn the pages of Rhazes' treatise, the glory of Bagdad lives again, and once more we salaam this pathfinder in medicine.

(1493–1541)

PARACELSUS

A striking similarity with the doctrines of Darwin is found in the view of Paracelsus, that the origin of everything is simply the transformation of germs always existing (and therefore is a metamorphosis), as well as in the fact that he maintained that every object and being originated at the expense of, and through the destruction of, another—a doctrine in which we see already developed the war of individual against individual, and the struggle for existence, so much talked about nowadays.

BAAS: *History of Medicine.*

All diseases, according to the prevalent idea, came from excess in either bile, phlegm, or blood. Paracelsus maintained that each disease had its own definite existence, with definite cause and sequences, and must be antagonized by specific remedies. This was the inauguration of the modern method of combating disease. No progress was possible until this view of its nature was adopted.

VENABLE: *History of Chemistry.*

IV

PARACELSUS

The road that leads to the inaccessible rock called Browning requires sturdy legs for climbing. Yet the ascent is not barren: on the rugged summit, lilies cannot grow, but the edelweiss thrives. This most enigmatical of poets has written a poem on the most enigmatical of scientists. The production is long, sometimes tedious and often incomprehensible, but it contains this immortal passage:

> Are there not, dear Michal,
> Two points in the adventure of the diver:
> One—when, a beggar, he prepares to plunge,
> One—when, a prince, he rises, with his pearl?
> Festus, I plunge!

Here we have an epitome of the life of Paracelsus. He did not stand on the shore of conventionality and admire the treasures that antiquity had gathered. He was a dauntless diver, and stripping himself naked, he leapt into unknown seas of thought. The pearls with which he rose are for us to exhibit in the pages that follow.

Everything connected with this man is remarkable, even his full name: Philippus Aureolus Theophrastus Paracelsus Bombastus von Hohenheim. It has been calculated that he received only two-fifths of this at baptism. For instance, he coined the name Paracelsus to indicate his superiority to Celsus.

He was born at an interesting time: when Europe stretched her limbs after a sleep of a thousand years in a bed of darkness; he lived during the period that Columbus discovered America, and Luther cleft Catholicism in twain, and Copernicus remodeled astronomy.

His birthplace was near the little Swiss town of Maria-Einsiedeln—where the Black Virgin is still worshiped. Fame selects odd places to lay her children: perhaps because she is whimsical and knows they will not be lost. Boerhaave was born in the village of Voorhout; he sleeps in the medical Valhalla.

The mother of Paracelsus was the superintendent of a hospital. His father—the illegitimate son of a grandmaster of the Teutonic order—was a physician of repute. His father was his first teacher, and the turbulent son ever venerated his memory. When a parent earnestly undertakes to educate his child, the result is brilliant—provided the child is brilliant. The fathers of Hippocrates and Galen had reason to think so. So did the sire of Paracelsus.

It is believed that when Paracelsus was three or four years old he was castrated by a hog. According to others it was a drunken soldier, while still others say it was his own father who performed the act. It is agreed that Paracelsus had no connections with women; yet it was he who introduced mercurials for syphilis. Some claim that because of his emasculation, Paracelsus never had a beard, but there are passages on record in which Paracelsus boasts that there is more wisdom in his beard than in the heads of all the ancient sages. Paracelsus appears to have been rachitic in his youth, and like many rickety children was precocious.

He never graduated from a college. He read few books and kept no library. But the amount and extent of his travels were astonishing. He is certainly the Marco Polo of medicine, though several of the ancient physicians—Hippocrates, Dioscorides, Galen—likewise heard the call of roving blood. He roamed through many lands: he saw the Baltic, he climbed the Seven Hills, he stood in Russia and beyond. And everywhere he sought to acquire knowledge from all peoples: peasants, thieves, fortune-tellers, musicians, midwives, barbers, gypsies, bath-keepers, loafers, old women—and even from physicians.

His restless eyes were ever open for truth, his unsatisfied spirit sought relief in discoveries. He scorned the written works of the past. He believed in independent meditation and original observation—which is all very well for an ingenious and daring thinker like Paracelsus, but would never do for all our internes and externes. One needs keen eyesight to read the book of nature. "My accusers," he remonstrates in his piquant and poetic style, "complain that I have not entered the temple of knowledge through the legitimate door. But which one is the truly legitimate door? Galenus and Avicenna or Nature? I have entered through the door of Nature: her light, and not the lamp of an apothecary's shop has illuminated my way."

Paracelsus was an iconoclast: he had no use for the medicine of his day. His aim was to reform it from beginning to end. He was not the highest type of the reformer. He had not the calm dignity and lofty reserve of Giordano Bruno, he lacked the sublimity of Spinoza, and the modesty of Darwin was not his. He had a streak of clownishness in him and possessed the elements of a buffoon. He was often as gross as the aristocrats of his time, and could have engaged in drinking-bouts with Martin Luther. His self-advertising habits were distasteful. Paracelsus blew noisy blasts on his own horn. He covered his breast with medals, and his brow was decked with laurels of his own plucking. He sang odes in his own honor, and was never weary of celebrating his great self. There was a complacent cocksureness about him that would have roused the ire of a turtledove. "Tell me, Galenic doctor," he jauntily asks, "on what foundation you stand? Have you ever cured podagra, have you ever dared to attack leprosy, or healed dropsy? Truly I think you will be silent and allow that Theophrastus is your master. If you really wish to learn, listen to what I say, attend to what I write." Such vanity overtops the loftiest peaks of his native Alps. Compared to Paracelsus, the magpie is shy and the peacock modest. Now we have said the worst about him; but does it explain how he discovered Zinc?

It is fortunate for medicine that Paracelsus did not succeed in wiping out Galen, who was the more scientific and less fantastic of the two. Paracelsus lived in superstitious times, and was a son of his age. He believed there were spirits in the air, gnomes in the earth, nymphs in the water, and salamanders in the fire. He reveled in the mysteries of the kabala; he adored astrology; he was an adept in alchemy; he invented the alkahest. From his wanderings in the Orient he brought home outlandish mixtures of spiritism, theosophy, occultism, and other crazy creeds which find adherents even in the twentieth century.

But it is extremely fortunate for medicine that Paracelsus fought Galen, for the physician of Pergamus cast an hypnotic spell over the profession. For several centuries physicians argued in this manner: "Galen said so; ergo, it must be so. Not all your experiments or observations are of any value." New evidence was not permitted to displace Galen's old errors. In this poisonous atmosphere Science could not breathe. When we recall such criminal reverence for authority, we can forgive the dictum of the judicious Boerhaave: "Galen has done more harm than good."

Paracelsus did not tread the accepted path with closed eyes. His radicalism was needed, his influence was healthy. He who breaks up superstitious veneration for the past, becomes a benefactor of the future. His fault lay in his attempt to replace the authority of Galen by the authority of Paracelsus, and for this he is blameworthy. But he was the yeast that leavened the medical dough. The lance of his free wit punctured many an orthodox error. He smote the pedestals of falsehood, and the unclean images fell. *Festus, I plunge!*

Paracelsus' conception of medicine was due to a sort of neo-platonic pantheism—whatever that may be—and was based on the relationship that man the microcosm bears to nature the macrocosm. "There is nothing in heaven and earth," he says, "which is not in man, and God who is in heaven is also in man." He believed that diseases were caused by the action of certain constituents in the universe acting on the corresponding elements in man. Therefore in order to be able to treat man, it was necessary to understand all nature. No theory could well be more irrational than this, and it naturally led Paracelsus to serious errors. For if disease is due to a conflict between the macrocosmus and the microcosmus, it follows that Astrology is more important for a physician than Anatomy, and it seems that Paracelsus actually thought so!

Paracelsus claimed that medicine rests on four pillars: Philosophy, Astronomy, Alchemy, Virtue. He defined these terms differently than we do now, but on the whole we may say that these pillars, like the columns of the Roman Forum, have fallen: a test-tube is stronger than them all.

Paracelsus agreed with Basil Valentine that man and the entire universe were composed of three primary mystic elements: mercury, sulphur, salt. Whatever sublimes is mercury; whatever burns is sulphur; whatever remains is salt.

He anticipated the mesmerism of Mesmer, and the *similia similibus curantur* of Hahnemann—for which anticipations we need not be especially thankful to him.

Paracelsus believed that medicines, like women, were known by their shapes. It was his theory that everything in nature was made for the human race, and that God put his signature on all drugs. The orchis-root is testiculate and therefore should be used for diseases of the testicle; the flower of the euphrasia has a black spot which indicates that it should be used for the pupil of the eye; if a plant has more than one color, it means it possesses more than one therapeutic property; the juice of celandine is yellow, and consequently good for jaundice; the spines of a thistle will heal pains in the side. Why should frogs be used for plagues? That's easy; because frogs are disgusting and plagues are disgusting.

Of course Paracelsus had many recipes for the prolongation of life. And not only did he think we could live indefinitely, but he believed a human embryo could be created by chemical means. This is now considered impossible, but before 1828 it was likewise deemed impossible to manufacture an organic compound in a laboratory. Paracelsus' dream may yet be realized; surely Jacques Loeb has made a magnificent beginning. But this is perhaps a problem for the twenty-fifth century.

Little will here be said concerning Paracelsus' notions on Magic. We have scant inclination to elucidate his aniadum and aquastor, or explain his evestrum and erodinium. We feel no interest in his hidden iliasters, ultimate essences, sidereal bodies, astral corpses, haunted houses and poisoned moons. Expositions of such vagaries may well be left to unsound mediums and mystics like Helena Blavatsky and Franz Hartmann.

Out of these voluminous writings on Mystery we will content ourselves with two short extracts: the first, unpleasant; the second, delightful. In *De Pestilitate* he says, "But if a witch desires to poison a man with her eyes, she will go to a place where she expects to meet him. When he approaches she will look into the poisoned mirror, and then, after hiding the mirror, look into his eyes, and the influence of the poison passes from the mirror into her eyes and from her eyes into the eyes of that person; but a witch may cure her own eyes by making a fire and staring into it, and then taking the menstrual cloth, and after tying it around a stone, throwing it into the fire. After the cloth is burnt, she extinguishes the fire with her urine, and her eyes will be cured; but her enemy may become blind."

From his *De Morbis Amentium* we quote a pleasanter passage: "Some will fall deeply in love with the person who administers to them these philtres prepared by sorcerers; and it has happened that in this way masters and mistresses have fallen deeply in love with servants who administered them such things; and thus they became themselves the servants of their own servants. Even horses, dogs and other animals have thus been brought under the influence of such spells. If women administer such things to men the latter may fall so deeply in love with the former as to be unable to think of anything else but them; and if men administer such things to women, the latter will continually think of them."

So far the reader has had no glimpse of the promised Paracelsian pearls. Let us begin by stating that although Paracelsus himself was a star in the alchemical sky, he asserted "the object of true alchemy is not to make gold but to prepare medicines." It was he who made chemistry the handmaid of medicine, and inaugurated the era of iatro-chemistry. *Festus, I plunge!*

His followers—Spagyrists, they were called—ceased to look for the Philosopher's Stone that cures the diseases of metals, and commenced to search for various remedies to heal the ills of mankind. Paracelsus himself enriched the Materia Medica.

Tin was known from the remotest antiquity, Moses and Homer mention it, the Phœnicians traded in it a thousand years before Christ, but it remained for Paracelsus to suggest the use of *stanni pulvis* as an anthelmintic.

Paracelsus brought antimony into special vogue, but credit for first mention of its medicinal properties belongs to that strange monk, the chemical myth, Basil Valentine. We do not know of anyone who employed the lead salts for internal treatment, prior to Paracelsus. He had much to do with the introduction of copper sulphate into therapeutics. He was largely instrumental in adding iron salts and milk of sulphur to the medical armamentarium.

The discovery of zinc must be accredited to Paracelsus; at any rate he is the first to mention zinc as a separate metal, distinct from its alloy. The passage in which he refers to it is worth quoting for historical reasons:

> There is another metal, zinc, which is in general unknown. It is a distinct metal of a different origin, though adulterated with many other metals. It can be melted, for it consists of three principles, but it is not malleable. In its color it is unlike all others, and

does not grow in the same manner; but with its *ultima materia* I am as yet unacquainted, for it is almost as strange in its properties as *argentum vivum*. It admits of no mixture, will not bear the *fabricationes* of other metals, but keeps itself entirely to itself.

He was the first to use zinc oxide and zinc sulphate medicinally; he showed how to purify the latter. As far as we know, Paracelsus was the first who was acquainted with ethereal oil.

Paracelsus' favorite remedy was what he called laudanum, —which to-day means tincture of opium. The interesting and even important question arises if his laudanum was similar to *laudanum liquidum Sydenhami*. Nearly all authors answer in the affirmative, but Monsarrat denies it with angry emphasis, and hotly insists that Paracelsus' laudanum never even saw opium. It should be remarked, however, that Dr. Monsarrat sees little good in Paracelsus. There is no doubt that Paracelsus, against the opposition of Galenists, did much to advance the therapeutic reputation of opium—though we are here met by the puzzle that Galen himself had recommended it.

It follows that Paracelsus' idea that chemistry should be an adjunct of medicine, his advocacy of numerous mineral remedies, the impetus he gave to the preparation of new drugs, considerably enlarged the scope of pharmacy, which up to that time concerned itself chiefly with roots and herbs, syrups and the like.

Paracelsus did praiseworthy work in combating the polypharmacy of his time, which put hundreds of ingredients in a single prescription. "Bah!" he exclaims, "this miserable compounding business! Yet the woman requires only one man to father her child; many seeds only corrupt it. Mix many kinds of seeds and bray them like an apothecary and bury them in the earth; no fruit will come from them."

By treating iron filings with oil of vitriol Paracelsus noticed a gas whose evolution he referred to as "the rising of a wind." This is the first mention of hydrogen; but of course

Paracelsus did not know its elementary nature, and confused it with air. Not he, but Henry Cavendish must be considered the discoverer of our lightest element.

Mercury was employed externally by the Arabians, as a remedy for vermin and cutaneous diseases; but to Paracelsus we are indebted for its internal administration in syphilis. This alone should be sufficient for immortality. From that time on, mercury remained the specific for this loathsome affliction, and the history of syphilis cannot be written with the name of Paracelsus left out. Several of his original observations concerning this disease are correct. He divided it into stages, observed the heredity of syphilis, and was aware of its influence on the course of other diseases. He knew that gonorrhea was due to coitus, but he made the mistake of believing it to be an initial stage of syphilis, and therefore labeled it French gonorrhea.

This error, though a serious one, is not surprising, when we recall how strenuously the unity of the gonorrheal and syphilitic virus was upheld by the acute John Hunter, who had moreover the advantage of living in the eighteenth century. Hunter, for experimental purposes, inoculated himself on the prepuce and glans, with the pus of a virulent gonorrhea; unhappily, the subject from whom he took the poison had also a chancre in his urethra; the result was that Hunter developed not only gonorrhea but syphilis. Thereupon the illustrious and heroic experimentalist proclaimed that a gonorrheal secretion produces syphilis, and that there is but a single venereal virus. Folks were not in the habit of holding interrogation marks up to John Hunter in venereology; what he said, the profession believed; his disastrous mistake was persisted in until the syphilological work of Philippe Ricord straightened out matters. Once again do we see the fatal results of following authority blindly.

Hunter had also written, "I have not seen that the brain, heart, stomach, liver, kidneys, and other viscera have been attacked by syphilis, although such cases have been described by authors." On account of this flippant and careless statement, nothing further was said of visceral syphilis for over half a century!

In the sixteenth century there was a chasm of animosity between Medicine and Surgery, but Paracelsus was a member of both branches. He was the first to point out the connection between goitre of the parents and cretinism of the offspring; his description of hospital gangrene is admirable; his ideas on the treatment of wounds were more rational in several respects than those of his contemporaries; he declared that suppuration was bad healing and insisted on the cleanliness of wounds; across the centuries let Lister greet his precursor.

As a rule, the German historians regard Paracelsus more favorably than do the medical authors of other nations. No doubt they are grateful to him because he was the first scientist to write in the German tongue—and he wrote like a literary master. He knew the value of antithesis, and when his ink-horn felt the quill, it became a crucible that coined golden epigrams.

He has another connection with literature: the Englishman of letters seems fond of him. Paracelsus has the exceptional honor of being mentioned by Shakespeare, who in his comedy, *All's Well That Ends Well,* puts this phrase in the mouth of Lafeu: "Both of Galen and Paracelsus, of all the learned and authentic fellows." Bacon praises his endeavor to get at the truth through the light of experience. Another Elizabethan—O rare Ben Jonson!—refers to Paracelsus in his drama *Volpone;* Samuel Butler, in his celebrated *Hudibras,* speaks of the laudanum which Paracelsus kept in the pommel of his long sword; Kingsley praises him wholeheartedly; but his staunchest supporter is Robert Browning, who in a note to his poem goes so far as to state that Paracelsus is the father of modern chemistry and the discoverer of the circulation of the blood—poor Harvey!

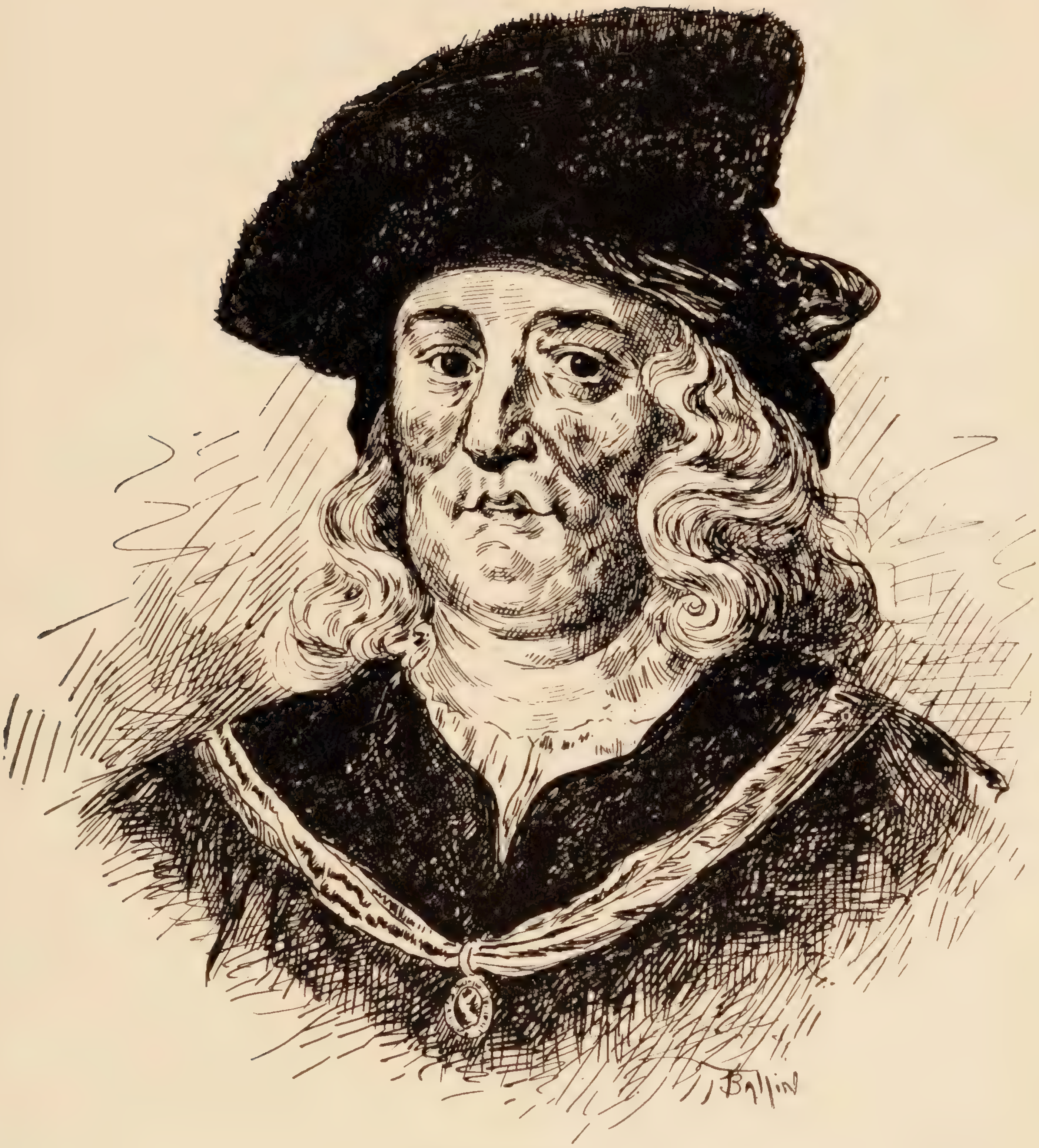
There is probably no character in general history, and certainly not one in medical history, about whom such diverse estimates have been expressed as of Paracelsus. To Zimmermann he is an ass, to Hans Locher he is the greatest of Swiss physicians; to Freind he is a loud-mouthed humbug, to Jules Andrieu he is the best of men; to Dalton he is an ignorant vagabond, to Creighton he is a sagacious reformer; to Thorpe he is a worthless charlatan, to Baas he is a high-minded professional man; to Monsarrat he is a parasite hanging on the skirts of science, to Venable he is the torch that lit up the darkness of his age; to Keith Norman Macdonald he is the chief quack on record, to Anna M. Stoddart he is the chief name in medicine. Perhaps we are expected to be wise and say that the truth lies in the middle, but may the memory of Theophile Gautier's wit save us from such hackneyed business.

No physician has left so much labor for medical historians as he who said: "In nature's battle against disease the physician is but the helper, who furnishes nature with weapons, the apothecary is but the smith who forges them. The business of the physician is therefore to give to nature what she needs for her battle. . . . Nature is the physician." Beginning with Karl Friedrich Heinrich Marx who made his reputation on Herophilus and Paracelsus, Friedrich Mook, Eduard Schubert, John Ferguson, Hugo Magnus, Julius Hartmann, Franz Strunz, Julius Pagel and Max Neuburger have distinguished themselves as Paracelsian students. Karl Aberle concerned himself with the iconography of Paracelsus. John Maxson Stillman's recent monograph is a temperate estimate, further valuable because of its many translated passages.

The young Sudhoff won his first laurels in medical history by his original studies of the manuscripts of Paracelsus; after an elapse of half a century, new leaves are to be entwined with the old, for the venerable scholar has announced he will terminate his career by issuing, with notes and commentary, the complete works of Paracelsus, in fifteen volumes. An important feature of this enterprise is that for the first time it will assemble all the unprinted manuscripts of Paracelsus, including the philosophical and theological writings. Why the latter were unpublished in the lifetime of Paracelsus is apparent from these sentiments: "Those who stand with the Pope consider him a living saint, those who stand with the Arian also hold him a righteous man, those who hold with Zwingli likewise consider him a righteous man, those who stand with Luther hold him a true prophet. Thus are the people deceived. Every fool praises his own motley. He who depends on the Pope rests on the sand, he who depends on Zwingli depends on hollow ground, he who depends upon Luther depends on a reed. They all deem themselves each above the other, and denounce one another as Antichrists, heathens and heretics, and are but four pairs of breeches from one cloth. It is with them as with a tree that has been twice grafted and bears white and yellow pears. Whoever opposes them and speaks the truth, he must die. How many thousands have they strangled and caused to be strangled in recent years." Had Frobenius put this manuscript into print for its author, the fate of Paracelsus would have been that of Charles Estienne—classicist and scientist, first to demonstrate the spinal canal, whose reward was to perish in the dungeons of religious intolerance. The only man of that age who remained immune while he thrust his pen at fanaticism was Erasmus—the unique monk who scorned a cardinal's hat in his lifetime, and refused a priest's attendance at his death-bed; the unapproachable Erasmus, the "Voltaire of the Renaissance," whose wit mocked the wickedness of kings and the corruption of prelates.

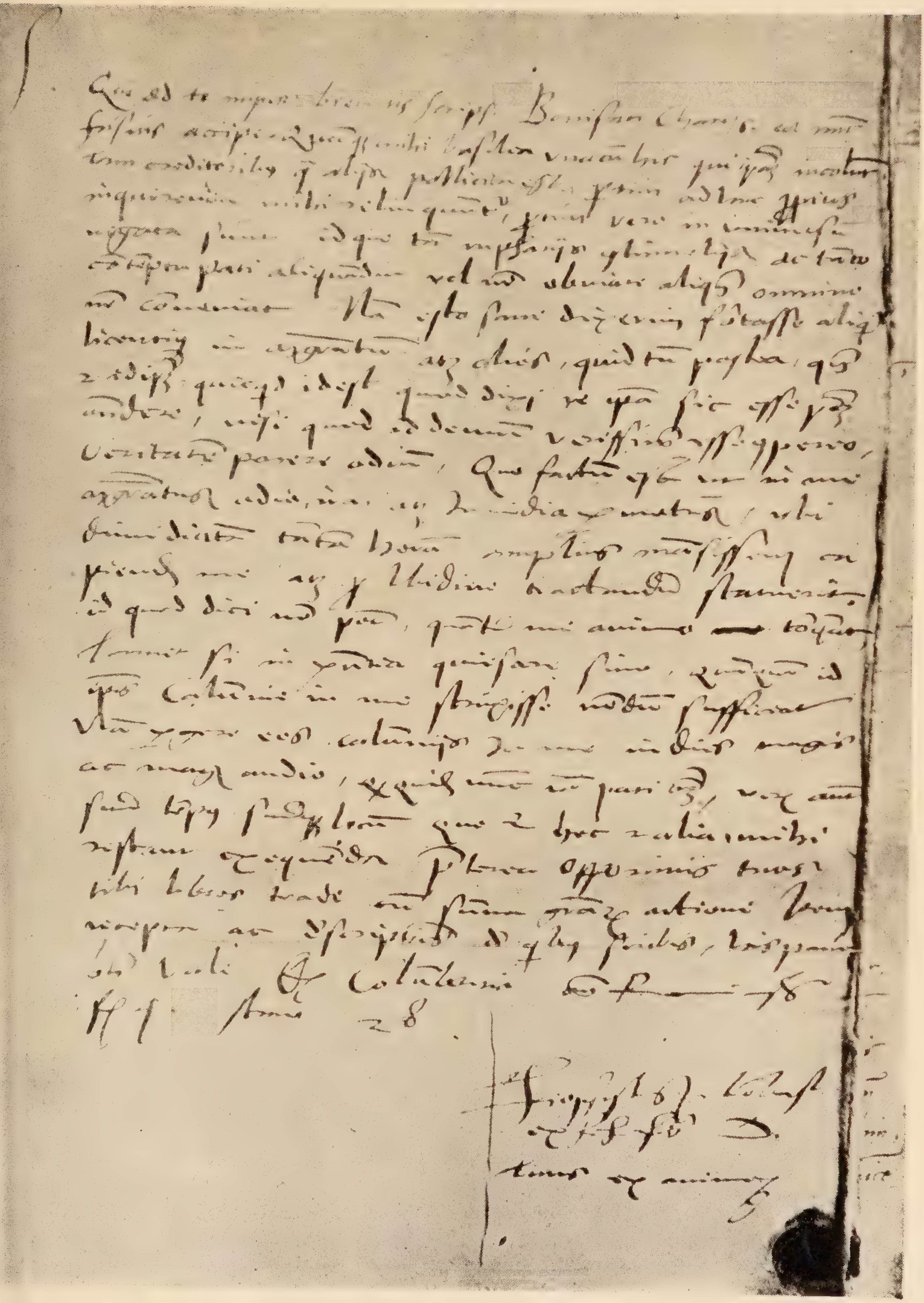
A sapient Frenchman said, "Calumniate! Calumniate! Calumniate!—some of it will stick." Paracelsus had numerous enemies, and some of it has stuck. To discredit Paracelsus, Basil Valentine was invented! Slander of Paracelsus yet comes from those who find his independence annoying, and his exuberant originality irritating. It should be remembered that Paracelsus was irregular, because he was much ahead of the medical knowledge of his day. Had Paracelsus been willing

PARACELSUS



PARACELSUS

HOLBEIN'S ERASMUS



HANDWRITING OF PARACELSUS

Sudhoff's Paracelsus, Reihe i, Bd. vi, Tafel v.

to conform to authority he would have attained to place and power, but he always remained poor. "My poverty," he says, "was thrown in my face by a Burgomaster who had perhaps only seen doctors attired in silken robes, never basking in tattered rags in the sunshine. So it was decreed I was not a physician."

Paracelsus tells us why he became a reformer: "Since I saw that the doctrine accomplished nothing but the making of corpses, deaths, murder, deformity, cripples, and decay, and had no foundation, I was compelled to pursue the truth in another way, to seek another basis, which I have attained after hard labor." He had a noble conception of the duty of a physician, and was so anxious to cure that he exclaimed, "If God will not help me, so help me the Devil!" In the presence of the sick, Paracelsus was a changed man: his arrogance and bombast turned to humanity and charity. His heart was naturally noble, and at such times especially so. He felt himself a father to the patient, which proves him a genuine physician. The maimed, the diseased, the suffering, came to him:

A man named Bartholomew who had for two years a pain in his side, a woman who had a great swelling on her thigh, a soldier who was shot in the breast with a forked arrow, a young man who had a crusty ulcer on his chin, one whose stomach was swollen and standing out, a lad whose finger was eaten to the bone with disease, a goldsmith whose skull had been injured, one Jonas who fell in love with one Sabina and then fell beside himself, the daughter of one Oliver who was pale and ate small stones and chalk, a boy of eighteen who had a black bladder appear where a tooth was drawn, a young gentlewoman named Ascania who had pain all over her body, one who had a flux of blood from a severed artery, a knight who suffered a stroke of apoplexy, a man of the country who was stung by an adder, one who was wounded in the tunicle of the heart, a young man who was vexed with a continual and violent cough, a certain woman who was troubled with a disease in her secret parts, one named Vermundus who was so weak in his head that he staggered as if drunk, a fair young man who was infected with the pox through the filthy sin of the Sodomites, one named Gallenus who had lost his speech, one who was troubled with a great burning of the urine, one who had a cataract of the eyes, a woman whose courses were so long that she was ready to give up the ghost, a sucking child whose palate was full of pustules, one Gotius who had a bone out of joint for several days, a lawyer who was long sick of the colic, a man of threescore years who was full of melancholy humors, a woman who three months after conception feared abortion, a certain man who had carnal company with his wife but could void no sperm, a certain Queen who through the retention of her menses had her tongue inflamed, a German prince who was sick with the frenzy, a gentlewoman of name who was troubled with a suffocation of the matrix, a certain baron who was sorely afflicted with syphilis: these came with faith to Paracelsus, and the great physician healed many wounds, and many invalids became whole and sound.

Because of his famous cures, Paracelsus was made professor at Basel. In this pretty town, near a chestnut-covered terrace that overlooks the hills of the Black Forest, still stands the house where lived two illustrious friends and patients who sought health at the hands of Paracelsus—Frobenius the printer, and Erasmus the philosopher. "I cannot," wrote Erasmus, "offer thee a reward equal to thy art and knowledge, but I surely offer thee a grateful soul. Thou hast called from the shades Frobenius who is my other half: if thou restorest me also thou restorest each through the other. May fortune favor that thou remain in Basel."

So Paracelsus came to the University, looking as natural as the portrait of himself, ascribed to the great Tintoretto. He regarded the students with those strange eyes which have been described by Charles Kingsley as "wild, intense, hungry, homeless, defiant and yet complaining eyes; the eyes of a man who struggles to tell a great secret, and cannot find words for it, and yet wonders why men cannot understand, and will not believe what seems to him as clear as day."

The new professor did many astonishing things that day. Instead of using monkish Latin, he lectured in native German, which then seemed "even to the German emperor, suitable only to address horses."

Paracelsus had with him a pile of books—the works of Galen, Avicenna, Averroes and other medical masters. It was surprising to see the iconoclast in company with these authorities. But Paracelsus did not quote from them. He placed some sulphur in a brazier, set fire to it, cast in the sacred volumes, and burnt up the idols. *Festus, I plunge!*

"Follow me," he cried, "not I you, follow me Avicenna, Galen, Rhazes, Montagnana, Mesuë, and ye others! Follow me, not I you! ye of Paris, Montpellier, ye of Suabia, ye of Meissen, ye of Cologne, ye of Vienna and the banks of the Danube and the Rhine, ye islands of the sea, Italy, Dalmatia, Sarmatia, Athens, ye Greeks, ye Arabs, ye Israelites, not one of you shall remain in the remotest corner upon whom the dogs shall not void their urine! How does this please you, Cacophrastus? This dung must ye eat! And ye Calefactores, ye shall become chimney-sweeps! What will you think when the sect of Theophrastus triumphs? I am to be the monarch, and the monarchy will belong to me. For I tell you boldly that the hair from the back of my head knows more than all your writers put together; my shoe-buckles have more wisdom in them than either Galen or Avicenna; and my beard more experience than your whole Academy."

Paracelsus was not the sort of man who can occupy official positions. He disturbed the doctors in their commercial transactions. In his capacity of town-physician, he demanded to examine the drugs of the apothecaries, to see if they were of sufficient purity. Basel became a vat where trouble brewed. It was discovered that Paracelsus had no degree. Objection was found to his unprofessional dress. He was accused of immorality. His servant testified that for his own amusement Paracelsus often conjured up legions of devils.

About this time Paracelsus and a prelate agreed that if the skill of the former could remove the sickness of the latter, one hundred florins should be the reward. Treatment was commenced, and the disease disappeared so swiftly that the churchman thought six florins would be adequate payment. Paracelsus brought the matter into court, but the judges found it convenient to forget the law of contract, and rendered a verdict for the defendant. Enraged words leaped to the eloquent tongue of that pugnacious plaintiff, and treating the bench as if it were a prisoner, and he himself the magistrate, Paracelsus delivered a lecture on justice. The legal lights of Basel determined to punish this trespass into the realms of jurisprudence. The friends of Paracelsus got wind of the matter; they informed him, and he fled.

For the rest of his life Paracelsus was a homeless wanderer. In 1528 he was at Colmar; in 1529 at Nuremberg; in 1530 at Munich, Amberg, Noerdlingen, Regensburg; in 1531 at St. Gall; in 1535 we find him at Appenzall, Zurich, Pfeffers; in 1536 he journeyed to Augsburg; he was at Villach in 1538; in 1540 he was at Mindelheim; in 1541, under the protection of an archbishop, he came to Salzburg in the Tyrol; he needed rest, and soon found it.

In a little inn called the White Horse, he died—as the result of a long debauch, his enemies say.

And at my door the Pale Horse stands,
To bear me forth to unknown lands.

Three hundred and fifty years later his skeleton was unearthed for reburial; an examination revealed the fact that his skull was smaller than the average, having a capacity of 1300 cubic centimeters, instead of the usual 1450. But a more curious discovery was made. A fracture was found on his temporal bone which surgeons declared could have been made only during life. To-day many believe he was assassinated by hirelings of his foes. It is doubtful if the truth will ever be known.

A contradictory character; he blundered much; his mistakes were manifold, but he had some great ideas, and this is a virtue that few possess.

Jacobus Sylvius was an element: he was a disciple of Galen, and could not be subdivided into anything else. Haller was an harmonious compound: the elements in him were united in certain definite proportions. Paracelsus was a strange mixture: the multitudinous elements that entered into his cosmos were erratically arranged.

In spite of his adherence to mysticism he had the great intelligence to say, "Ere the world perishes, many arts now ascribed to the work of the devil will become public, and we shall then see that the most of these effects depend upon natural forces."

Festus, I plunge!

(1511–1553)

MICHAEL SERVETUS

Since the ancients have no right to so noble a discovery as that of the circulation of the blood, it may be worth while to inquire, to whom of the moderns the glory of it is due; for this is also exceedingly contested. The first step that was made towards it, was the finding that the whole mass of the blood passes through the lungs, by the pulmonary artery and vein. The first that I could ever find that had a distinct idea of this matter, was Michael Servetus, a Spanish physician.

W. Wotton, in 1694.

It is interesting to note that the three most distinguished pupils of the great orthodox anatomist [Sylvius] were accused of heresy in religion as well as science. Vesalius was persecuted by the theologians, Etienne perished in the dungeons of the Inquisition, while Servetus, as all know, met a yet more terrible fate at the hands of Calvin. But the man who nearly anticipated Harvey deserves more than a mere mention. Medical history first meets with Michael Servetus, M.A., M.B., Paris, on a February afternoon, 1538, in the anatomy theatre of that university, where he has just finished dissecting a human subject, and is disputing with the dean of the medical faculty about some astrological lectures he had been giving. A few days later he sends "certain Italian friends" to apologise to the dean. It may have been in dissecting this subject, a rare thing at that time, that he noticed the solidity of the cardiac septum and large size of the pulmonary artery, which led him to the discovery of the so-called lesser circulation.

E. T. Withington, in 1894

V

MICHAEL SERVETUS

An orange orchard in Hispania, with olive trees upon the hills, a fountain weeping crystal tears by moonlight, an ancient castle in the distance, a golden-sanded river flowing along a flower-laden shore.

Paler yet than ever the lover looks to-night, and gently his trembling fingers tinkle the guitar. He nears the silvery fountain so its dashing spray can cool his heated brow. The night-air bears his song of sorrow to the moon, but no fair hand is at the lattice, and no sweet face peeps forth from the casement.

His passion rises, a string breaks—of the guitar only? His stricken voice halts in his throat, he is silent. . . . The green-leaved vines climb upon the wall—up to her chamber-window. He will cling to them, he too will raise himself—up to her chamber-window. He climbs, he whispers, no answer, he calls, he cries *misericordias,* he waits, a faint step—O, with what a mad and fevered ecstasy he lifts his free hand to the moon! The step comes closer, the air grows sweeter, heaven draws nearer,—she opens her chamber-window. She speaks, "My love, I come to thee."

They walk in the garden below. How fragrant are the orange-blossoms to-night, and so musically the cascade falls—is it keeping time with a Spanish love-ditty? Dip thy fingers in the fountain, perilous maiden, and soothe the youth's fevered brow, for he burns and the fault is thine. False was the advice—who would not go blissful delirious at thy touch? Ah, beauty of Spain, be kind—what night better than this? With the moon for a marriage-ring, the white blossoms for thy bridal veil, the olive trees for canopy, the flowing cascade for hymeneal song, and the voice of the nightingale for priest? They melt into each other's arms, they swoon with the passion divine.

Sweet-night, dream-night, love-night—must thou end? A cock is crowing for the dawn, but the moon though wan, still glimmers in the heavens, therefore, sleep yet on. . . . The cock crows again—lustily. Alas, that those entwining arms should be released. The sun is above thee—awake.

"The day is abroad," he speaks, "and I must go."

"Ah me," she sighs, "do not go from me. Linger yet awhile within the shadow of my olive trees."

"I leave this land," he answers, "even now the Inquisitors search for me and the sun is red."

And something sombre and severe
  O'er the enchanted landscape reigned
A terror in the atmosphere
As if King Philip listened near,
Or Torquemada the austere,
  His ghostly sway maintained.

The spirit of Spain was expressed by Isabella: "In the name of Christ and his maidmother," said the Queen, "I have caused great misery, and have depopulated towns and districts and provinces and kingdoms." In the soft warm land of Spain the *auto-da-fé* was in its glory, and the curling smoke from the hell-fires of the Inquisition mingled with the sailing clouds, and cunning instruments were plied upon the sensitive nerves of pain, and the ruddy life-fluid of Hebrews reddened the dirty gutters, and darkened chambers heard the shrieks of mangled unbelievers, and in sympathy the crimson sun streaked the Spanish sky with blood!

Michael Servetus came from Spain. Michael Servetus left Spain to escape the fagots of the Inquisition—he had no desire to die in a scorching blaze. He thought the Protestant countries would be more tolerant than his Papist Hispania.

Servetus was mistaken when he imagined that the Lutherans and Calvinists would permit independent speculation. These men broke away from the tyranny of the Popes—but they established a tyranny of their own. Nor were they more favorably disposed towards science than the older ecclesiastics —they accepted only the science of the Pentateuch. When Copernicus published his book on the orbits of celestial bodies, the Protestant joined with the Catholic in a chorus of denunciation, and Luther himself declared, "The fool wants to upset the whole science of astronomy, but as Holy Scriptures show, Joshua commanded the sun to stand still, and not the earth."

Servetus was the greatest man of his age. His brain was the torch that burned to enlighten the world. He was the irritant that caused the sixteenth century to turn uneasy in its sleep. It could not rest till he was off the earth. No nation was big enough to hold him—he came, he taught, he was banished. Servetus was beyond the Renaissance. Nearer the truth than his contemporaries, Servetus was a type of the intellectual outcast.

Whatever subject he touched, he illumined. When he edited the geographical work of Ptolemy, his notes showed that he did not consider geography merely a matter of maps. His intellect was broad enough to grasp the connection that geography had with botany, zoölogy and astronomy. He was the first to recognize this important relationship of the sciences, and Tollin and other authorities consider him the Father of Comparative Geography.

In the preface, Servetus, writing as a geographer and not as a panegyrist, said: "Judea has been falsely cried up for beauty, richness, and fertility, since those who have traveled in it have found it poor, barren and utterly devoid of pleasantness." Because of this statement he was accused of attacking the authority of Moses, who had described Judea as a land overflowing with milk and honey!

His theological views, of a pantheistic nature, caused him to be equally abhorred by Catholic and Protestant. Michael

Servetus did not believe in the Trinity, was tolerant to Moors, and bothered little with Original Sin and Baptism of Infants. Therefore Martin Bucer, who is described as a very moderate man, used very moderate language and said that Servetus should only be torn to pieces and disembowelled. And Philip Melanchthon, whom everyone called mild, wished in a mild sort of way that the heretical Spaniard should merely be done to death by sword or fire.

The book in which Servetus first set forth his heterodox opinions was published at Haguenau in 1531 and entitled *De Trinitatis Erroribus.* It brought him into collision with a theologian who believed strongly in the Trinity. He was an uncanny individual—everything that was human was alien to him. He was a cold soul, and could warm himself only at the flames of hell. His only joy consisted in contemplating the fact that at least nine-tenths of mankind was predestined to eternal damnation. He was not ashamed to declare that the infant, while yet in the mother's womb, was already an abomination to God. He formulated a theological system so pitiless, that if the lower animals could understand it, throughout the jungle would run a shudder at the inhumane dogmas. His *Ordannances Ecclesiastiques* were iron rules which were enforced with unyielding rigor. He not only announced the opinions that his flock at Geneva must entertain, but he prescribed the garments that all must wear. He whipped a girl for singing a song. He considered himself a reformer; he broke away from the tyranny of the Popes, but he established a theocracy of his own—including a Protestant Inquisition. Spies eavesdropped among the people; for any nonconformity, howsoever slight or unintentional, the harshest punishments were administered; physical measures were employed, and often the cries of tortured prisoners made Switzerland resemble Spain. He might even be willing to burn a heretic. No doubt this man was sincere, but he was also conceited: he thought an insult to John Calvin was blasphemy against God.

Calvin engaged in polemics with Servetus. Servetus de-

SERVETUS

feated him. At least that was the general opinion at the time, and when Calvin heard a laugh at his expense, wounded pride rankled in his unforgiving bosom; furious and malevolent, he waited for revenge. But enough of Calvin—for the present; we may meet him again.

At Lyons, while engaged in editing scientific works for the firm of Trechsel, Servetus became friendly with the physician Symphorien Champier. Like the other scholars of the period of the Revival of Learning, Champier eulogized Hippocrates and Galen in highest hyperbole; he clamored to see them in their own dress, for although the Greeks had remained authorities throughout the Middle Ages, they were not known in the original, but only through faulty translations, and by means of commentaries and compilations, chiefly from Arabic sources. The enthusiasts refused to drink any longer from these second-hand sources—they thirsted for the fountainheads of knowledge. On all sides was heard the cry for Greece and Rome; Hebrew, Christian and Mohammedan, gave way to the resurrected glory of Hellas. The awakened cities fought, not for the spoils of war, but for classic manuscripts.

In those days Lyons was one of the intellectual centers where Athens was born again. Besides Champier and Servetus, Rabelais was there, fresh from his lectures on Hippocrates and Galen at Montpellier, now editing the *Aphorisms* of the former and the *Ars Parva* of the latter. But it was not as a physician that the world's greatest humorist was to earn his laurels.

At Lyons was also Rabelais' friend, the talented Etienne Dolet, loud in his praises of Cicero, and printing everything interesting that came into his hands—but not for long, for the theological faculty of the Sorbonne accused the young man of atheism, and he was strangled and burnt. Ah, mediævalism was not dead, after all. It was a dangerous age for a thinker like Michael Servetus.

Servetus decided to follow the profession of Champier, and accordingly registered at the renowned University of Paris.

Jacobus Sylvius, who has given his name to various structures of the human body, was the shining light of the faculty—but the light too often sputtered because the teacher blocked the path of his advancing pupils with the folios of Galen, crying: "At this sign, stop; all medical wisdom ends here!"

A more interesting personality was Guinterius of Andernach. Here was a man who had risen from the depths; he had stood in the streets of Deventer, imploring the passersby for bread. But hunger never prevented Guinterius from studying Greek, and the learned beggar became a professor in the University of Louvain. But even success did not chill his passion for knowledge, and at the age of forty he began to study medicine. After graduation, he remained in Paris, practicing and teaching, and translating the Greek physicians into Latin. Other events crowded into his career; when the Reformation came, Guinterius sided with Luther, and his life was endangered; he wandered from place to place, but romance dogged his footsteps, and Guinterius eventually became a nobleman of Strassburg.

Guinterius was delighted with the vivacious Servetus. Guinterius had another pupil whom he admired—a Netherlander whose scalpel opened up the era of modern medicine—and the teacher linked the names of these earnest scholars: "Andreas Vesalius, a young man, by Hercules! of singular zeal in the study of anatomy; and Michael Servetus, deeply imbued with learning of every kind, and behind none in his knowledge of the Galenic doctrine. With the aid of these two, I have examined the muscles, veins, arteries and nerves of the whole body, and demonstrated them to all the students."

In 1538, Servetus graduated with the highest honors. He became a lecturer at the university on the medical sciences and mathematics, and his wide and varied culture attracted distinguished visitors, including the Archbishop of Vienne, whose confidential physician Servetus became.

A life of peace, and much glory and money would have been his, had he been able to keep his critical faculty in abeyance. But this was the one thing Michael Servetus could not do. He published a learned medical work, *Syruporum Universa Ratio,* in which from a therapeutic and physiological standpoint he criticized the great Galen, whose preëminent authority as an anatomist was after an elapse of fourteen centuries at last to be undermined by the publication of Vesalius' monumental *De Humani Corporis Fabrica,* while his knowledge of obstetrics was attacked by the famous midwife, Louise Bourgeois, who claimed that the unmarried master never knew the pregnant uterus of a woman. It was not only Galenism, but the Arabian system which was then much in vogue, that Servetus sought to displace.

His book was a distinct advance in the art of prescribing. For the nauseous mixtures—the mere names of which now act as emetics—he introduced more palatable drugs; in these pages we see the first rational attempt to avoid incompatibilities, and we find also the first suggestion of what the pharmacist calls vehicles, that is, pleasant-smelling and sweet-tasting ingredients of no use in themselves, but valuable as carrying other drugs of therapeutic action.

In those days people took books seriously, and *Syruporum Universa Ratio* aroused intense antagonism. The Faculty of Paris attempted to impeach Servetus. Dissensions divided the university, riots occurred in the streets, and some of the students were severely injured. Who to-day would get excited over a treatise on sweetened syrups?

It must be admitted that Servetus was not averse to argumentation. He had a ready tongue and a facile pen—and he liked to use both. There must have been a sort of child-like vanity about him, for he sent Calvin one of his manuscripts and asked him what he thought of it.

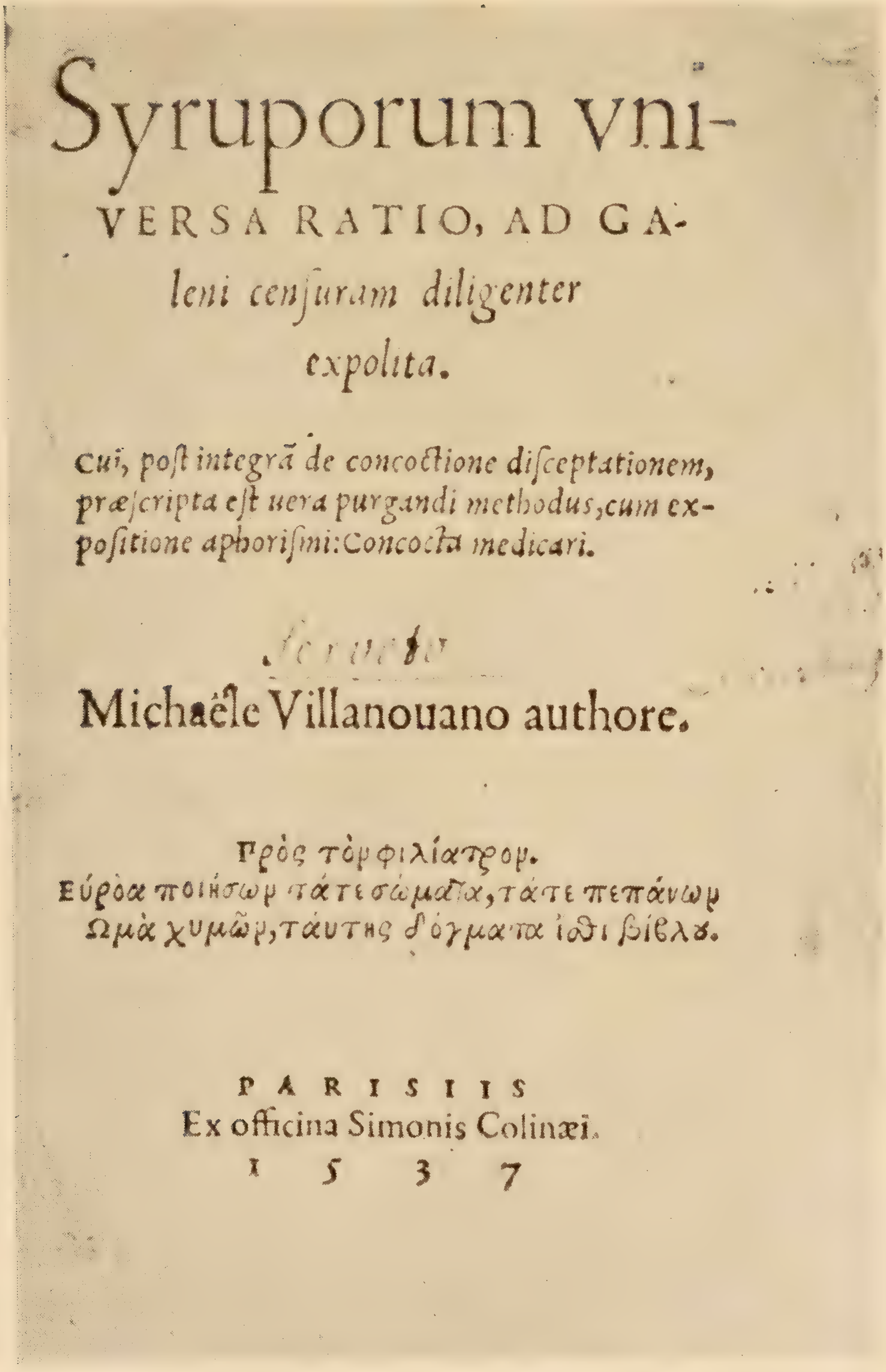
A stranger rode into Louyset, and the next day wandered into Geneva, where he earnestly asked for a boat to take him toward Zurich on his way to Naples. He had escaped from prison, and like Baumgarten in Schiller's *Wilhelm Tell,* might have exclaimed:

> Then must I fall into the tyrant's hands,
> And with the port of safety close in sight!
> Yonder it lies—I reach it with mine eyes,
> My very voice can echo to its shores;
> There is the boat to carry me across;
> Yet here despairing, helpless must I lie!

Unhappier was his fate, for instead of the helping hand of the Swiss hero to row him through the storm in safety, the despotic voice of Calvin, like a second Gessler, was heard commanding his immediate arrest. Servetus was again imprisoned, and the Christian Hercules (as Beza called Calvin) labored for a death-sentence.

The trial lasted from August till October, and several passages deemed heretical were read from Servetus' latest book, which had recently been published—*Christianismi Restitutio.* Calvin, tirelessly malignant, was the chief prosecutor. There was no escape from the implacable Genevan. Servetus had defeated him once—it was now Calvin's turn. He had the infidel on the hip and he smote him hard. Yet even without Calvin, Servetus' life was in danger, for during the month of June he had been burnt in effigy at Vienne, and in July the Roman Catholic Inquisition condemned him to death. But as Calvin was anxious for the honor of burning a heretic, he would not relinquish Michael Servetus, and on October 26, 1553, his tribunal read the following judgment:

> Against Michael Servetus of Villeneuve, in the kingdom of Arragon, in Spain: Because in his book he calls the Trinity a devil, and a monster with three heads; because contrary to what Scripture says, he calls Jesus Christ a Son of David; and says that the baptism of little infants is only an invention of witchcraft; and because of many other points and articles and execrable blasphemies with which the said book is all stuffed, hugely scandalous and against the honor and majesty of God, of the Son of God, and of the Holy Spirit; and because Servetus, full of malice,



Syruporum vniuersa ratio, ad Galeni cenſuram diligenter expolita.

Cui, poſt integrā de concoctione diſceptationem, præſcripta eſt uera purgandi methodus, cum expoſitione aphoriſmi: Concocta medicari.

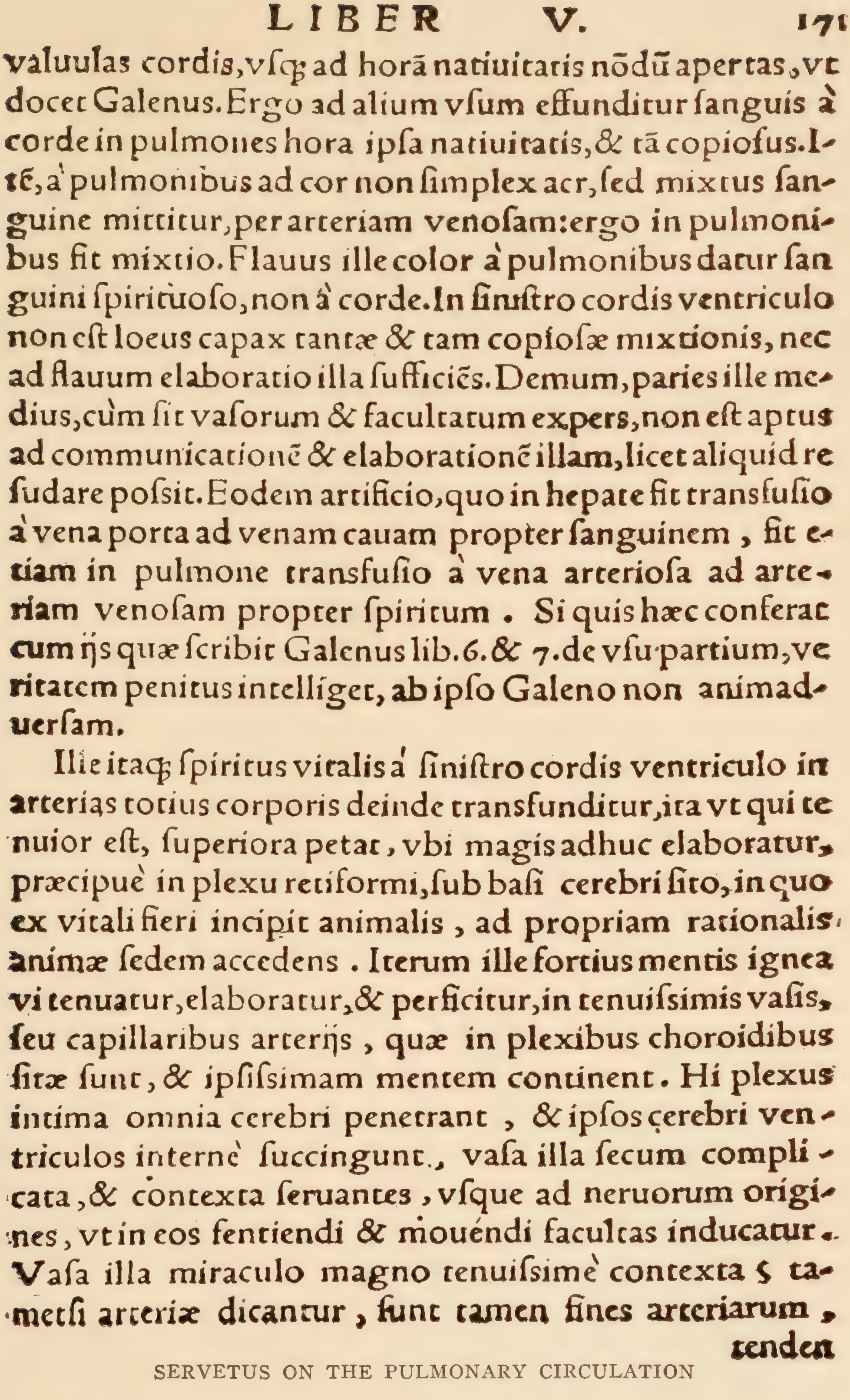
Serveto

Michaële Villanouano authore.

Πρὸς τὸν φιλίατρον.
Σύρὸα ποιήσων τά τε σώματα, τά τε πεπάνων
Ωμὰ χυμῶν, ταύτης δόγματα ἴσθι βίβλου.

PARISIIS
Ex officina Simonis Colinæi.
1537

SERVETUS ON SYRUPS
Block loaned by Sir William Osler.



LIBER V. 171

valuulas cordis,vſqꝫ ad horã natiuitatis nõdũ apertas,vt docet Galenus. Ergo ad alium vſum effunditur ſanguis à corde in pulmones hora ipſa natiuitatis,& tã copioſus. Itẽ,à pulmonibus ad cor non ſimplex aer,ſed mixtus ſanguine mittitur,per arteriam venoſam:ergo in pulmonibus fit mixtio. Flauus ille color à pulmonibus datur ſanguini ſpirituoſo,non à corde. In ſiniſtro cordis ventriculo non eſt locus capax tantæ & tam copioſæ mixtionis, nec ad flauum elaboratio illa ſufficiẽs. Demum,paries ille medius,cùm ſit vaſorum & facultatum expers,non eſt aptus ad communicationẽ & elaborationẽ illam,licet aliquid reſudare poſsit. Eodem artificio,quo in hepate fit transfuſio à vena porta ad venam cauam propter ſanguinem, fit etiam in pulmone transfuſio à vena arterioſa ad arteriam venoſam propter ſpiritum. Si quis hæc conferat cum ijs quæ ſcribit Galenus lib.6.& 7.de vſu partium,veritatem penitus intelliget, ab ipſo Galeno non animaduerſam.

Ille itaqꝫ ſpiritus vitalis à ſiniſtro cordis ventriculo in arterias totius corporis deinde transfunditur,ita vt qui tenuior eſt, ſuperiora petat, vbi magis adhuc elaboratur, præcipuè in plexu retiformi,ſub baſi cerebri ſito,in quo ex vitali fieri incipit animalis, ad propriam rationalis animæ ſedem accedens. Iterum ille fortius mentis ignea vi tenuatur,elaboratur,& perficitur,in tenuiſsimis vaſis, ſeu capillaribus arterijs, quæ in plexibus choroidibus ſitæ ſunt, & ipſiſsimam mentem continent. Hi plexus intima omnia cerebri penetrant, & ipſos cerebri ventriculos internè ſuccingunt, vaſa illa ſecum complicata,& contexta ſeruantes, vſque ad neruorum origines, vt in eos ſentiendi & mouendi facultas inducatur. Vaſa illa miraculo magno tenuiſsimè contexta ; tametſi arteriæ dicantur, ſunt tamen fines arteriarum,

tenden

SERVETUS ON THE PULMONARY CIRCULATION

has entitled his book thus directed against God and the holy evangelical doctrine, *Restoration of Christianity,* and that for the better seducing and deceiving the poor ignorants, and for more easily infecting with this unhappy and wretched poison the readers of his said book, under the shade of sound doctrine: therefore——

For these and other just reasons us hereto moving, desiring to purge the Church of God of such infection, and to cut off from it a corrupt member—having well consulted with our fellow-citizens, and having invoked the name of God to guide us to right judgment, sitting on the tribunal in the place of our ancestors—having God, and His Holy Scriptures before our eyes, saying in the name of the Father, of the Son and of the Holy Ghost, by this our definite sentence which we give here in writing, we condemn thee, M. Servetus, to be bound, and led to the place of Champel, there to be fastened to a stake, and burned alive, with thy book, as well written by thy hand as printed, even till thy body be reduced to ashes, and thus wilt thou finish thy days, to furnish an example to others who might wish to commit the like.

As said before, parts of his latest book were read as evidence against him, but there was a certain passage which the prosecution overlooked, so we will quote it here: "The vital spirit," wrote Servetus, "is generated by the mixture in the lungs of the inspired air with the subtly elaborated blood, which the right ventricle sends to the left. The communication between the ventricles, however, is not made through the midwall of the heart, but in a wonderful way the fluid blood is conducted by a long detour from the right ventricle through the lungs, where it is acted on by the lungs and becomes red in color, passes from the arteria venosa into the vena arteriosa, whence it is finally drawn by the diastole into the left ventricle."

Reader, this remarkable passage was the first account of the lesser circulation! There stood Michael Servetus, the discoverer of the pulmonic circulation of the blood, the anticipator of Harvey, condemned to death for writing the book that contained the most momentous physiological discovery of the time. So effectually was the edition destroyed, that Harvey knew not his true precursor. Harvey quotes Realdus Columbus, but not Michael Servetus. But closer than Columbus or Cesalpinus or Vesalius or Fallopius, had Servetus come to solving the riddle of the circulation. He deserved the blessings of the world, but received a death-sentence. No voice was raised in his behalf. Not only John Calvin, but all Christendom, was guilty.

As the fatal day approached, a visitor entered Servetus' cell. It was John Calvin. The prisoner looked at the pale face and burning eyes of the bigot, but remained silent. His passion for discussion had deserted him—perhaps he had cast enough invaluable pearls before uncomprehending swine. The opponents parted forever.

It was the melancholy month—October. Pensive Autumn faintly sighed, the trees had shed their glory, and the fields were filled with pain.

Under an ancient arcade the processions passed. Beneath the gate of the castle they marched. The Bourg-de-Four they crossed, and ascended the street of Saint Anthony. Southward they turned, and left the walls of the town. The Lord-Lieutenant rode a mighty horse, and by his side galloped a herald. Behind them came the archers, and in the midst of all walked a proud and taciturn physician whose prescriptions had failed to purge the age of fanaticism. A crowd swelled the rear—poor and unlearned—but not one in all that throng envied him who walked in silence.

The sick leaves moaned, the dead leaves fell. Destruction was in the air.

A little hill lay before the procession. Up this incline rode the Lord-Lieutenant, followed by the others. The summit was gained, and then the eye gazed on the scene which has enchanted a thousand inspired poets. Far away gleamed the deep blue waters of the lovely Lake of Geneva, formed like a graceful halfmoon, and on one side, as if guarding the verdant valley, towered an undulating ridge of lofty mountains.—A dying leaf shook among the branches, and losing its hold was swept away by the wind.

On the hill was set a stake around which were piled the fagots—of green wood so they would burn slowly. Michael Servetus was a devoted believer in God, and even warmly attached to the person of Christ, but because he rejected the Trinity the multitude considered him an incorrigible atheist, and a child who was present at the execution might have used the words Shelley wrote when a boy:

> I was an infant when my mother went
> To see an atheist burned. She took me there:
> The dark-robed priests were met around the pile;
> The multitude was gazing silently;
> And as the culprit passed with dauntless mien,
> Tempered disdain in his unaltering eye,
> Mixed with a quiet smile, shone calmly forth:
> The thirsty fire crept round his manly limbs,
> His resolute eyes were scorched to blindness soon;
> His death-pang rent my heart! the insensate mob
> Uttered a cry of triumph, and I wept.
> Weep not, child! cried my mother, for that man
> Has said, There is no God.

By several twists of an iron chain, Servetus was bound to the stake. To mock him, a crown of straw dipped in sulphur was put upon his head. By his side they tied the child of his brain—the book that should have made an epoch. The torch blazed, and a hot sheet of flame, as if it were the spirit of Calvin, leapt high in air and pounced upon his body. . . . Through the escaping smoke Michael Servetus lifted his unseeing eyes to heaven, and cried in agony, *Misericordias! Misericordias!*

O miracle accursed—Spain had come to Switzerland—Behold, how the crimson sun did streak the skies with blood!

(1514–1564)

ANDREAS VESALIUS

The young of all times have rebelled against the shackles of tradition, but in no age did these shackles hang more heavy than at the beginning of the sixteenth century. Those imposed by the Church were no less burdensome than the dogmas that shackled Medicine, but to the aid of the rebellious youths of that day had come the printed page: and the presses having done their duty for fifty years in reproducing and multiplying the works of authority were now, some of them, being utilized for the dissemination of revolutionary, nay heretical ideas. So Vesalius with this new weapon toppled Galen from his seat, and in the process, before his end, ran counter to the church. What Servetus might have done for medical science we can only conjecture had he not chosen with ineffective disguise to tilt in theological lists over man's soul rather than openly to use his lance in the no less controversial matters relating to his body.

HARVEY CUSHING: *Introduction to Canano.*

VI

ANDREAS VESALIUS

The day merges itself in the museful dusk, it yields to the silent caress of the clasping shadows, it permits the pensive embrace of the gentle evening.

Yet all is not dim nor darkness—there is still twilight and starlight and moonlight, and lo! from the window gleams the cheerful lamplight.

Cease to ply your tasks, O men. Follow the nearest path that leads to home. For you a flame is burning, and a loving woman waits. Do not tarry, for she expects you. If you linger she will peer with anxious eyes into the night—and see nothing. See, she keeps the supper warm, and your chair is ready. Take your place at the head of the table and sit among your family. Hasten, the darkness is deepening.

Soon the soft-shod Morpheus lowers his sable curtain, and all the world seeks its bed and travels to the City of Sleep. On the pillows of forgetfulness it lies, and covers its body with the blankets of peace. The bustle is stopped, and quarrels are over at last. Anger is gone and sorrow has fled. Now worry is routed, and misery made to halt. Here are the portals of repose; come and enter, O weeping eyes and wounded heart. Where are the tears, and what has become of pain? Ah, they enter not the beautiful land of oblivion, and of them the slumberers know naught. Soft is the air of dreamland, and easily it is inhaled. Chant the lullaby song of rest, and raise not your mantle, O somnolent god. Over all silently waves the soundless banner of a silken calm.

Sleep on, weary world; sleep, sleep, sleep.

Refrain—for all do not sleep. The night has a life as intense as day. It is then that the humble badger comes from its burrow and the cricket chirps to its little mate. It is then that the lonely poet stands beneath the stars and frees his soul from the limitations of time and space. In the damp of the night the caterpillars crawl forth to feed on the leaves, and the plaintive whip-poor-will laments its name in sadness. Now the nightingale's golden tongue is unloosed, and like a song-intoxicated spirit it warbles a melody to the beloved and blushful rose. The solemn owl, that on the bough of the sycamore tree blinked like a fool all day, has become the king of the air and will outface the royal eagle. With a deep and doleful tone it hoots through the silent forests, and its mysterious, melancholy voice, so ghost-like and ghastly, sends a thrill of terror through the hearts of oak. Fearlessly outspreading its pinions it sweeps like a silence over the distant hills—the hunter of the night is after his prey.

Strange women, members of the oldest of professions, smile upon men they have not seen before. Across the way, at the next house, a faint cry is heard—a new individual has begun its existence.

The night is the time for lovers—the whole earth swarms with them. The night is their trysting-time, for they are worshipers of the moon. The night kindly hides them from the outside world, and converts every retreat into a holy place. . . . A little boat glides along the placid stream . . . the oar ceases to be held, the unguided boat drifts with the tide . . . but think not it is empty. Arm-in-arm through Lovers' Lane they wander; many sit at the water's edge; and there is scarce a spreading tree but shelters a youth and a maid. Into this sacred secrecy we must no longer pry, for the gentle words that are now uttered are meant for themselves alone and the brooding night—the night that has a romantic heart but tells no tales.

Alas! that some should wish the night to cover deeds that daylight must not see. Hark, why are the footsteps of that fellow as silent as his shadow? If he had the wings of the bat he could not sail more noiseless through the air. The furred cat could learn from him the soundless tread. To the end of the town he walks, and e'en when the watchful dogs bark aloud he is as quiet as the swinging carcass of the convict that hangs moldering on the gibbet. Ah! save us, Virgin Mary, for thither is he bound. Stealthily he climbs the slippery steps and steals the corpse. (The moon looks calmly at his pale face.) Oh, ye blessed saints, protect us from his evil eye—it is the same youth that last week robbed the charnel house and dug the dead from their graves!

The living thief descends from the gallows and carries the dead thief on his shoulder. A figure emerges from the gloom. Heaven grant it be an officer of the law. Well, it is, but he sees nothing and passes on. The youth drags the decomposing carcass toward his home. Its odor is frightful, but it does not offend his nostrils. He clutches the decayed frame tighter, it is to him a precious thing.

At last it is safe in his own room. Impatiently the eager anatomist draws his knife and begins at once to cut the body. It he be discovered, he too may be among the dead, for the Merciful Church expressly forbids the dissection of dead human bodies, and this very year the fires of the Inquisition have saved many heretic souls by burning their sinful flesh. Aye, it would go hard for the impious youth, and rightly too, for the infallible Church has always preached that as God took a rib from Adam to make Eve, man has one rib less than woman, but since this bold blasphemer began to dissect human bodies he has discovered the untruth of this theory.

Have a care, Vesalius, or the hot flames of the Holy Inquisition will burn your own body into an ash for the winds to scatter.

Now the moon goes away, and the traveling sun comes home. The badger has returned to its hole, and the voice of the cricket is still. The poet's vision is faded, and the sorrowful whip-poor-will is silent. The caterpillar has ceased its feast, and the nightingale sings no more to the bashful rose.

The helpless owl is stupid again, and weaker birds dash with impunity against his blinking eyes.

The day with all its duties has dawned, and the fond lovers have separated.

They who have done unlawful deeds by night now tremble at the blazing sun and its searching rays, but Andreas Vesalius is unafraid. This proud moment he would defy the Council, and the piled-up fagots of the dreaded Inquisition could not make him recant. In his eyes shines a light that seems to dazzle the beams of the heavenly sun itself. He, too, feels himself high . . . high . . . above all clouds. So Praxagoras must have looked and felt when first he distinguished arteries from veins, for during the night Vesalius has discovered the structure of the human heart!

Vesalius was a born dissector; as a child he cut up the bodies of mice and moles, of cats and dogs,—not for sport, but for knowledge. "It's in the blood," explained his mother as she watched him at work, for his great-great-grandfather had written commentaries on Avicenna, his great-grandfather taught medicine at Louvain, his grandfather was the physician of Mary of Burgundy, and his father was apothecary to Charles v.

Vesalius was a magnificent youth: he was dissatisfied with existing conditions. In his day, men learned anatomy by studying Galen, not by dissecting corpses. "If you trust Galen, why dissect?" they asked, and since everyone believed Galen, nobody dissected. When it did become necessary to make practical demonstrations to students, the lower animals were employed, usually a pig. Human cadavera were seldom exhibited. Moreover the scholastic pedants who taught anatomy did not deign to wield the scalpel themselves; the professor sat on an elevated seat, generally with a copy of Galen and Avicenna before him, and discussed learnedly; a demonstrator stood below, and with a long staff pointed to the organs; the dissection itself was performed by a barber.

No wonder Vesalius complained that the student learned less in an anatomical theater than a butcher might learn in his shop. He said his teacher never used his knife for any other purpose than to cut his steak. Warm blood coursed through the veins of Vesalius; during a demonstration, iritated at the awkwardness of the barbers, he thrust them aside and performed the dissection himself. "By Hercules!" exclaimed Guinterius, and looked with admiration at his talented and impetuous pupil.

All this was in Paris, and Vesalius longed to be in the land where anatomy was cultivated with more zeal than elsewhere—Italy, that immortal country so often destroyed by the rapacity of ecclesiastics and diplomatists, but ever reviving afresh with new beauty.

In 1537 Vesalius saluted the Queen of the Adriatic. Between Venice and the Vatican there existed an antagonism of long-standing. When the Pope said Yes, the Venetian senators said No. In the republic of Venice no churchman was permitted to hold a civil post, and throughout the hall of the great council often rang the sentry's warning-cry, *Fuori i Papalisti.*

But Vesalius never bothered his head about such matters; osteology and myology, and not politics and theology, were his concern. The Paduans, who were Venetians at that time, soon found room for Vesalius. They created the chair of anatomy for him, and thus at the age of twenty-two Andreas Vesalius of Brussels became a professor at the University of Padua.

His enthusiasm in anatomy was infectious. When Vesalius lectured no one thought that anatomy was as dry as dust. When the young professor cut a layer to expose a muscle or a nerve, five hundred auditors—students and teachers, officials and clerics—leaned forward with attention. No doubt the circumstance that whenever possible Vesalius adopted the novel procedure of dissecting the human cadaver instead of a pig or dog, served to add to the interest and curiosity of the spectators. (There were dissectors before Vesalius, yet human material was so scarce in the era when human beings were destroyed at any provocation, that when Rondolet, noted for his gentleness and piety, opened his anatomical course at Montpellier, he was forced to dissect the body of one of his own children.) The fame of Vesalius spread; other cities asked him to come and reveal to them the wonders of the human body.

He made so many discoveries that it is difficult to name them all. His researches on the vascular system were of extreme importance; he determined the position, form, and internal structure of the heart, and investigated the function of its fibers and valves. Among his other descriptions and discoveries may be mentioned a fuller account of the anatomy of the brain than had yet appeared; the first satisfactory description of the medical student's terror, the sphenoid bone, at the root of whose pterygoid process is a small aperture still called *foramen Vesalii;* the discovery of the canal which passes in the fetus between the umbilical vein and the vena cava. He showed that the sternum consists of three parts, and the sacrum of five or six. He was the first who described the omentum and its connection with the stomach, spleen and colon; the internal pterygoid muscle, the ductus venosus, the course of the vena azygos and subclavian vein, the absence of the "rete mirabile" in the brain, the five cerebral ventricles, and the non-glandular character of the caruncles. He likewise described accurately the mediastinium and pleura, the tensor tympani muscle, the labyrinth, the vestibule of the ear and the long process of the malleus, the fornix and septum, and he was the first whose views on the pylorus have been found correct.

Many who attended his demonstration marveled at the audacity of Vesalius; he spoke of the mistakes of Galen. Hardly more than a boy in years, he was not willing to abide by the dicta of the Pope of Anatomy—isn't it glorious to be young? Galen believed there was no marrow in the bones of the hand; he believed that during parturition there is a separation of the bones of the symphysis; he believed that the inferior maxilla consists of two pieces; he believed that the ascending vena cava arose from the liver; Vesalius proved that in each instance Galen was incorrect. Vesalius showed that Galen was wrong when he assumed the existence of a general muscle of the skin, an imputrescible bone of the heart, the os intermaxillare in adults, a decided curvature to the bones of the thigh and the upper arm. Before Vesalius finished with the Prince of Physicians, he demonstrated and corrected over two hundred Galenian errors. He disposed also of the resurrection-bone supposed to be lodged in the right great toe, and he approached the fagots of the Inquisition when he pointed out that Adam's missing rib was not missing. Pre-Vesalian anatomy is antiquated anatomy; Vesalian anatomy is modern anatomy.

At twenty-five Vesalius decided upon a vast undertaking: he began to write a book on anatomy which he was confident would revolutionize the entire science and supplant every other text-book in existence. It was to consist of seven parts: the first was to deal with bones and cartilages, the second with ligaments and muscles, the third with veins and arteries, the fourth with nerves, the fifth with organs of nutrition and generation, the sixth with heart and lungs, the seventh with the brain and organs of sense.

Vesalius could attend to the text himself, and it seems that he even drew some of the illustrations, but still an artist was needed to make the finest figures that ever adorned a medical work. Vesalius had his troubles, and he often complained that the artists were much more interested in painting Venus than in drawing his dissected carcasses. When we remember that preservative fluids were not used in those days it is not astonishing that the Titians and van Calcars and Coriolanos found less pleasure in decaying viscera than in the lively limbs of a living signorina. Vesalius was certainly exacting; at times the artist grew tired—and then curses were handed back and forth. More than once the distracted Vesalius envied the peaceful corpse that was safe from the antics of the artistic temperament. But Vesalius generously scattered money—a mystic commodity which inspires even such impractical men as artists—and the work advanced.

Such illustrations as Vesalius finally received must have compensated him for his travail. Such fine skulls and fascinating skeletons, such perfect viscera and beautiful muscles,—strictly correct from both the anatomical and artistic viewpoints—were revelations. It is true that the unique Giacomo Berengario of Carpi—the specialist in syphilis who amassed a fortune in Rome by treating rich priests for the French evil—had also done considerable work in the line of art-anatomy, but the illustrations of Vesalius were much superior.

During the summer of 1542 a merchant on his way to Basel carried in his train bulky blocks of wood—but they were precious beyond price. On these blocks was built the science of modern anatomy—they were the blocks of Vesalius' book. Vesalius had uneasy nights; he had a presentiment that the trader Danoni would not go straight to the printer Oporinus, but would get drunk on the way and lose his precious blocks; or he would be attacked by rival anatomists and the blocks would be stolen. But Danoni attended to his business and brought the blocks into the shop of Joannes Oporinus, the scholarly printer of Basel. Printing was a new art in those days, and a printer was a man of mark. Vesalius wrote to Oporinus begging him to take extreme care with his work; as Oporinus already possessed a European reputation for fidelity, he must have considered Vesalius' precaution unnecessary, but probably excused it on the ground of vanity of an author. Vesalius was nervous—he was sure that the shop of Oporinus would burn down—and he came to Basel himself to see that everything was all right.

In 1543 Vesalius' volume—magnificent in appearance, monumental in contents—came from the press. With the publication of *De Humani Corporis Fabrica* the treatises of Galen and Mondino and Guy de Chauliac became aniquated—still interesting for the historical student, but unimportant for the scientific worker. Vesalius was twenty-eight—in three years he accomplished what he had set out to do. Vesalius lived in the Golden Age of Anatomy; the greatest anatomists that ever held a scalpel were his contemporaries: Leonardo da Vinci, Cesalpinus, Servetus, Fallopius, Eustachius, the modest and gifted Canano, Ingrassias, Realdus Columbus. But the crowning masterpiece of that brilliant period is Andreas Vesalius' *De Humani Corporis Fabrica Libri Septem.* It conferred on its author this title: Father of Modern Anatomy.

Among the lamentable facts in the posthumous history of certain eminent men is the circumstance that though during life they sailed in the advance current of new ideas, no sooner are they dead than their followers convert them into a dam to beat back the overflowing river of progress. Thus it is that he who wished no limit to be placed on freedom, himself unwittingly becomes the clog by which men cry, "Halt!" Disciples are a nuisance; they forget we must march on—beyond their masters. If Heine is correct in assuming that heaven is ruled by an Aristophanes, surely nothing can move him more to mirth than to reflect that a mortal who is hunted by his contemporaries as a heretic, is considered by his posterity respectable enough to blow froth from the cream-puffs of platitude.

It was a wise old man who wrote the following lines, but unfortunately such an injunction is always disobeyed:

> I call to the world to distrust the accounts of my friends, but listen to my enemies, as I myself do;
> I charge you, forever reject those who would expound me, for I cannot expound myself;
> I charge that there be no theory or school founded out of me;
> I charge you to leave all free, as I have left all free.

How vast and wonderful was the mind of Aristotle, so limitless and immortal; but as soon as his teachings were enthroned as the ultimate authority from which there could be no appeal, the great Stagirite became a wound on the breast of science which needed drainage.

Galen had done mighty work for science, but his influence became positively harmful as soon as men exchanged their senses for the *ipse dixit* of the physician of Pergamus. Galen had corrected the errors of his eminent predecessors—amidst insult and abuse—but in due time he himself was turned into a veritable oracle, a god who disputed must not be, and when after many centuries, Vesalius in his turn, pointed out the shortcomings of the Galenian system, he made bitter enemies who struck him with stinging words.

During the sixteenth century it was sacrilege to dispute a verdict that had come out of Greece or Rome. So worshipful of antiquity was the Renaissance that when Rondelet and Pellicier, wandering through the marshes of the Camargue, came across the pink flowers of the water-germander which corresponded to the Scordium of the ancients, all Europe applauded the botanists who found a plant that Dioscorides and Pliny had known. And when the Garum was rediscovered,—that classic sauce whose virtues Horace had sung from his Sabine farm—a flood of praiseful poetry followed.

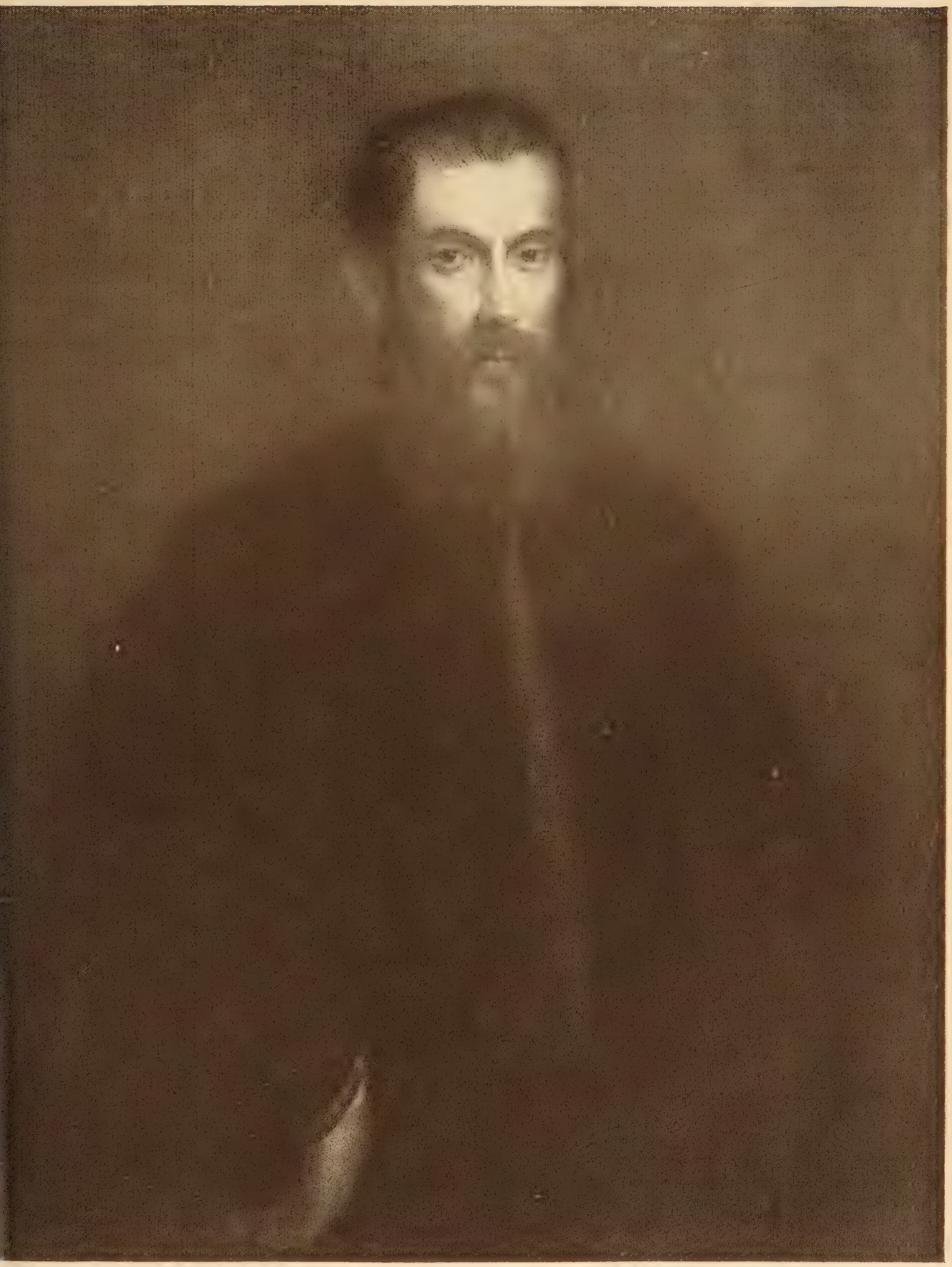
The men of the Middle Ages could never imbibe the spirit of Greek science; they could repeat only the dry letters. They never knew Greek medicine as it really was: they were acquainted only with its caricature. The men of the Renaissance were wiser, and throwing away translations and commentaries, they studied Hippocrates and Galen and Celsus in the original. This love of the imperishable classics was fruitful in results—but evil was mixed with the good. Greek antiquity was a dream of light; mediævalism was a nightmare. Nothing better could be read than the classic philosophers, and nothing worse than monkish psalters. But when the Greekophiles uttered the commandment, "Beyond Galen thou shalt not go,"—then came the harm. (As a revolt from this attitude, Petrus Ramus—he whose life-blood later swelled the crimson flood on the Night of Saint Bartholomew—wrote as his graduating thesis, "All that Aristotle taught is false.")

When the mediæval grammarians argued technical phases of their science, instead of using elegant language, they cursed, "May God confound thee for thy theory of irregular verbs," and now Jacobus Sylvius denounced Vesalius as an impious madman whose breath poisoned Europe.

LEONARDO DA VINCI

A crayon self-portrait at the Royal Library of Turin.

VESALIUS



VESALIUS

IOANNES OPERINUS, GRÆCÆ Linguæ Profeſſor, & Typographus Baſilien.
B
Naſc.
A°
Ob. Baſileæ
A°. 1568. 6. July.
Tu famam libris, vitam ſcriptoribus addis.
Pars tibi mercedis ſic ab utroq; venit

JOANNES OPORINUS

cholarly printer, professor of Greek literature at Basel, famous in the history of medicine as the publisher of Vesalius' Fabric of the Human Body.

The life of Vesalius was a struggle against the hypnotic effects of Galen's authority. If Galen had said that a kidney is larger than the liver, men would have believed it. For example, Galen had written that our thigh-bones are curved. Now, when even a cursory examination revealed the fact that our thigh-bones are straight, Sylvius still asserted that they were curved in a state of nature, and that their straightness was due to the narrow trousers which men wore. Galen had declared that man (irrespective of age) possessed an intermaxillary bone. Vesalius could not find it, and he said so,—he who could tell every bone in the human body blindfolded. But the Galenists refused to be convinced. A human skeleton was brought to Sylvius. "Where is this intermaxillary bone?" he was asked. The faithful Galenist answered angrily, "Man had this bone when Galen lived. If he has it no longer, it is because sensuality and luxury have deprived him of it." Galen also said there is a connection between the two ventricles, and thereafter every anatomist who examined the heart saw the hole. Then Andreas Vesalius looked, and said, "I don't see it." And he didn't—it isn't there.

Vesalius deserves endless credit for his criticisms. To supplant an authority is admirable. In science there should be guides, not despots; teachers, not tyrants. The great thing is, to leave all free! Let priests have their popes and bulls and dogmas, but give us the Open Road!

Since Vesalius did such glorious work in the days of his youth, it may be wondered what he accomplished during maturer years. The answer is: Nothing. His numerous enemies did not silence him, the Inquisition did not smite him in his prime, but the siren of aristocracy seduced him from science. He became the court-physician of Spain, and instead of brushing aside harmful traditions and opening up scientific vistas, he labored faithfully on the gouty toe of Charles v. He attended pompous dinners, and grew polite in manners and learned in etiquette. He was taught how low to bow to a thieving bishop, and how far to bend his knees to a luetic marquis. He took his place among the king's dwarfs and his jesters. Yet Vesalius seemed satisfied. He took unto himself a wife, made money, and exchanged the intellectual life for the easeful one. So the years passed.

Spain was in consternation; dismay was written on the impassive Hapsburg face; alarm hung over the peninsula—as if the commons of Castile were rising again in insurrection under the leadership of young Juan de Padilla and his gallant wife. But it was no second *guerra de las communidades* that now frightened Toledo and spread confusion throughout Tordesillas; it was a calamity of a different sort that threatened the stability of Hispania. The licentious Don Carlos had been chasing a girl, the girl ran away, Don Carlos followed, Don Carlos tripped, Don Carlos tumbled down the steps, Don Carlos broke his head. Don Carlos was not fair to look upon: he was a little fellow, with a lame leg, a crooked shoulder and a twisted brain, but he was the son of King Philip, and heir-apparent to the largest empire on the globe. If he should die, who would rule mankind? Ten days went by and Don Carlos was not yet out of danger; he breathed heavily, and developed high fever and erysipelas. The situation was critical; something extraordinary had to be done; at least that's what the Spanish physicians and prelates whispered together. From the churches of Seville and Alcala and Madrid arose prayers for the recovery of the prince. The miraculous image of the virgin of Atocha, and the bones of St. Justus and St. Pastor were placed upon his pillow. Philip knelt within the Jeronymite monastery, and promised God that if Don Carlos survived, he would heap gold upon every shrine in Spain. The Duke of Alva, that terrible and merciless man who crushed out the liberties of the Netherlands, remained all night at the foot of his bed. But a Netherlander also was in the room—Andreas Vesalius bent over the nasty abortion to see what science could accomplish. Even Miguel de Cervantes, in his most mocking moment, never imagined so preposterous a scene!

Vesalius received a book. It was written by a former pupil of his—Fallopius. In a leisure moment Vesalius commenced to glance through the volume. A tinge of jealousy crept through his veins. The Father of Anatomy read of anatomical discoveries of which he knew nothing. While he had been dawdling away his days in the performance of petty functions, science had been advancing. Vesalius grew sad. He felt himself a Lost Leader. Old memories awoke. He remembered how, long ago, he had taught anatomy to eager students. He recalled his own enthusiasm, his disputes, his demonstrations, his discoveries. . . . Fallopius even went so far as to point out some errors that Vesalius had made; Vesalius was enraged, but the effect was wholesome. While preparing an answer to Fallopius, his better nature reasserted itself. He determined to quit the pathologic court of Spain, and once again devote himself to the pursuit of knowledge.

About this time, after an obscure illness, a nobleman died, whereupon Vesalius decided to perform an autopsy, to determine, if possible, the disease which carried off this grandee. With his skilled hand he opened the chest . . . but then Vesalius saw, and all present saw, what they had not thought to see—a beating heart. The breezes carried the unpleasant news, the enemies of Vesalius accused him of impiety and murder, and the Inquisition sentenced the great anatomist to death. (According to a less-known story, Vesalius was thus condemned because while dissecting the mistress of a priest he discovered unmistakable evidence that Christ's bachelor had not kept his vows as to chastity.) But Philip II interceded for his Archiatrus, and as the merciless monarch was influential with the merciless institution, the punishment of Vesalius was commuted to a pilgrimage to the Holy Land. There is a story that Vesalius undertook this journey voluntarily, to get rid of the vigorous tongue of his wife. In this multiplicity of versions it is difficult to reach the truth, but it is generally believed—and there is contemporary testimony to support it—that it was to escape the fires of the Inquisition that Vesalius sailed over the waters to Palestine.

Not Jerusalem is the Holy Land, not Sinai's top, nor the Mount of Olives; not the Sea of the Plain, or the Pool of Siloam, and neither the waters of Merom nor the wilderness of Judea can claim the sacred name; neither the valley of Achor nor the fountain near Jericho, not Jacob's well nor where the river of Jordan rolls, but the land where man works for the welfare of man—this is Holy Land.

Gabriel Fallopius died young, and the Venetian senate invited Vesalius to again fill the Paduan professorship thus made vacant. So Vesalius left the palm-trees of Cyprus and sailed to the Ionian Sea. The winds blew, the billows rose like mad, an infuriated storm broke forth, and under the blue Italian sky, on the beauteous Isle of Zante, whose laurels and myrtles have been sung by old Homer and Virgil, the anatomist was wrecked.

A wandering goldsmith entered a wretched hut and was startled to see a corpse on the floor—a corpse that Andreas Vesalius would never dissect. The winds of heaven destroyed his life, but could not wipe out the remembrance of his life-work. He perished in hunger and misery, but bequeathed to posterity an immortal name. Whenever we think of the pathfinders who advanced the progress of science, we evoke a picture of the intrepid Vesalius, knife in hand, battling against the tyranny of tradition.

(1517–1590)

AMBROISE PARÉ

The Wars of Religion of the sixteenth and seventeenth centuries were fierce and prolonged, and the army surgeons of the time had much experience of the treatment of wounds. The most prominent of the military practitioners was the Frenchman, Ambroise Paré. He perceived the importance of anatomical knowledge and adapted his discoveries to the needs of Surgery. Paré did much to elevate the surgeon's profession from a despised handicraft to a position equal to that of other branches of the healing art.

Apart from the introduction of anatomical discipline into Surgery, Paré's four contributions to the surgical art were, firstly, his discovery that gunshot wounds are not "poisonous" as had theretofore been thought, and that therefore they do not require the application of boiling oil, but are best healed by soothing applications; secondly, the cognate doctrine that bleeding after amputations should be arrested, not by the terrible method of indiscriminate use of the red-hot cautery, but by simple ligature; thirdly, his advocacy of the method of turning the child in its mother's womb before delivery in certain abnormal cases; and fourthly, his ingenious devising of artificial limbs. None of these four was without precedent. Nevertheless, the eminence, skill, and wide experience of Paré were the main factor in the spread of these practices. But the greatest of all Paré's contributions to surgery was the service of his own personality, the example of his steadfast efforts to increase his knowledge of human anatomy and his skill in the art, and his constant emphasis on the surgeon's duty to exert his utmost efforts to avoid or relieve the patient's suffering.

CHARLES SINGER.

VII

AMBROISE PARÉ

The French were invading Turin. All armies are alike, and on their victorious way the soldiers of Francis I demolished the villas, broke the wheels of the mills, threw the nether stones in the thrifty brook, polluted the wells, poisoned the springs, staved-in the wine-casks, burnt the barns with the golden grain, and killed the cattle that fed on the fodder.

At the Pass of Suze the battle began—for the forts and trenches of the enemy blocked the way. The French gained steadily, and their foes retreated to the castle on the hill—Château de Villane. The conquerors followed in pursuit, and the hoofs of their horses made impressions on the wounded and the dying.

And from the dizzy precipices came another army—also greedy. Through the reddened air swept the huge vultures, and fastening their talons in the bodies of the dead, they gorged themselves—like leeches on the neck of a full-blooded peasant-woman.

Night descended silently—like the vultures. The field was strewn with horrors.

Here was one leg all alone, still dressed in a torn trouser. One fellow had a hole in the pit of his stomach through which the blood oozed like water from a leaking pipe. Here was a headless trunk with a smashed chest, and as something scarlet gushed from it in spurts, it looked like a staved-in wine case. Another had one eye torn out, and the remaining one beat in its socket like a battering-ram. Many tongues were enormously swollen, and hung out of the owners' mouths as if they were mad dogs. A horse cried terribly, tried in vain to rise, and fell dead, its hoofs loudly striking the ground. An officer's skull had disappeared some way, and the sensitive and delicate brain was exposed to the air.

They were piled in heaps—like logs of wood in front of a bin, only not so neatly arranged. And some of them moved like children's toys—stiffly, and without life. The broken delirious talk and the impotent cursing were heart-chilling. Blood-poisoning was setting-in. A young fellow began to dream of home—where waited a vacant chair and an empty heart. It is true that a man loves his wife when he lies wounded on a bloody battlefield. She seems to him so tender and true. In heaps, they were piled in dirty crimson heaps, and every part of the heap that was alive, suffered.

At daybreak the French again fired upon the castle. With spikes, stones and arquebuses the besieged stoutly defended their last stronghold. But one side must lose: a breach was made in the wall, and the French won the day. The ensign and captain were strangled and hanged on the battlements. All the soldiers taken alive were literally hacked to pieces.

Out of all that garrison only one was left in the land of the living. This was a little maid from sunny Italy, "a very fair young girl of Piedmont whom a great seigneur would have." Irresistible indeed is female beauty if even among the corpses and the carnage its power can still be felt. Through the centuries the sweet face of this girl captive looks upon us, reminding us much of the beautiful Briseis of the *Iliad:*

> Partroclus now th' unwilling Beauty brought;
> She in soft sorrows and in pensive thought,
> Past silent, as the heralds held her hand,
> And oft look'd back, slow moving o'er the strand.

Now that the battle was over, the soldiers put away their instruments of destruction, and the surgeons took out their lancets, forceps, pliers, dilators, incision-knives, drainage-tubes, amputating-saws and cataract-needles.

With the French was a young surgeon on his first campaign. He followed the usual method of treatment—he cauterized the wounds with scalding oil. He had read carefully John de Vigo's chapter on oil of elders mixed with a little treacle. But either he was too enthusiastic in its application, or there was an unexpectedly large number of wounded, for the boiling oil gave out. The inexperienced frightened surgeon could do nothing better than apply a simple dressing. He passed a most uneasy night, fully expecting that when he looked at his non-cauterized patients the next morning, he would find them dead from their wounds, reeking with gangrene, vile and livid like Lorenzo's face in the pot of basil. He arose earlier than usual, and vast was his astonishment on finding that those whom he had treated according to authority with the scorching oil were in great agony, suffering with severe inflammation at the edges of the wounds, while the others were quite comfortable, and had neither pain nor swelling.

Ambroise Paré had made his first discovery—a bedside observation ousted boiling oil and its tortures from commonsense surgery. "See," says he, "how I learned to treat gunshot wounds; not by books."

When Paré returned to the French capital after his first taste of war, he heard that a certain anatomist—then at the height of his fame—desired to see him. It was the distinguished Sylvius, and he invited Paré to dinner, and listened to his original views on the treatment of gunshot wounds. Sylvius was so impressed, that he gave Paré a bit of advice which sounds very modern—he told him to publish a book.

Encouragement from such a source was stimulating indeed, and when Paré was twenty-eight years of age, a volume bearing the following title appeared: *"The Manner of Treating Wounds made by Arquebuses and other Fire-Arms, and those Made by Arrows, Darts and the Like; and also by Burns Made Especially by Gunpowder.* Composed by Ambroise Paré, Master Barber-Surgeon in Paris." A small 8vo, of 61 pages, but what an era it ushered in!

A gorgeous copy of a later edition, printed on vellum with patterns of gold, was presented to the king's mistress, Diana of Poitiers. It is claimed that the sumptuous bindings in which this un-Grecian Diana indulged are almost without parallel. Her books were marked with her favorite symbols, the lunar crescent and the bow! Evidently this brazen Frenchwoman, merely because of the accident of a name, thought herself entitled to use the emblems of that shy goddess whose undraped limbs neither god nor man could see. These were the designs, however, that she put in Paré's book, and she also interlaced a D with an H, the H standing not for Heaven or its antonym, but for her royal lover, Henri.

So Ambroise Paré was now an author, but as he had exhausted neither the subject nor himself, he went on thinking.

Ambroise Paré was the son of a valet; many of the men whose deeds are chronicled by the historian of the medical sciences, sprang from a lowly origin.

It is fortunate that Paré was not a gentleman, for at that time surgery was regarded as unfit for an *homme de bon ton.* Besides, in those days, a man who underwent an academic education was apt to be mentally ruined for the rest of his life—unless he became a rebel.

The old Greeks were too wise to separate medicine and surgery, but the mediævalists could be counted upon to embrace all possible and impossible absurdities. Of course the circumstance that the Church "forbade the shedding of blood," *ecclesia abhorret a sanguine,*—though its own hands were crimson—had much to do with the degradation of surgery, but the scholastic conceits of the pedants and faculties reached such a pass that they refused to hold a knife, or perform a venesection themselves, or make a physical examination; the hand was expelled from the realm of science, and surgery was generally relegated to barbers.

Paré received no college training; the bloody battlefield was his university. He could not read Galen in the original, but he discussed a variety of injuries that were not contained in Galen, for they were caused by recently-invented firearms.

The barber's boy, who from cock-crow to evening had cut hair and shaved beards and combed wigs, confesses that he was not familiar with Greek or Latin—but he understood the language of wounds.

Paré served at the wars over thirty years, and though he was often in danger of death, and was even taken prisoner, he was never wounded. It is true that he was once poisoned, that his leg was once broken, and that he was bitten by a viper in an apothecary's shop, but these accidents occurred during the dangerous days of peace.

Probably because Paré was country-bred, he enjoyed excellent health all his long life. His flesh was heir to few ills. Unlike Boerhaave, Harvey, the Hunters, Sydenham, Linnæus, Berzelius, and so many other eminent medical men, he did not suffer from the respectable disease yclept gout, and had it not been for the wicked little nerves of the teeth that often throbbed like sleepless imps, Paré would have been fortunate indeed. But Shakespeare's Leonatio said truly to Antonio,

> For there was never yet philosopher
> That could endure the tooth-ache patiently.

The love which the French army had for Ambroise Paré was of unusual and extraordinary intensity, never before or since accorded to a non-combatant, and finding a parallel only in the affection which some centuries later it bore for the Man of Destiny.

Paré's mere presence was enough to re-animate a disheartened garrison, and at the Siege of Metz, when the French troops were sorely pressed and on the verge of surrender, their beloved surgeon, though far distant, was sent for. No sooner did he appear on the ramparts than a mighty shout arose. "We shall not die," they cried, "even though wounded. Paré is among us." They carried him off in triumph, they continued the defense, and achieved a victory. To inspire such feelings Paré must have been not only skillful, but very kind to the soldiers; a sort of Walt Whitman:

Many a soldier's loving arms around this neck have cross'd and rested,
Many a soldier's kiss dwells on these bearded lips.

In his vigorous old age, Paré wrote of his experiences at the wars: *Journeys in Diverse Places.* In them he repeats his motto, time and time again: "I dressed him and God cured him." Despite its excursions into gossip, the style is most admirable for clearness and simplicity, and its curious mixture of vanity and modesty makes it a rival of Pepys.

"I was on a rampart," wrote Paré, "watching the enemy pitch their camp, and seeing the crowd of idlers round the stream, I asked M. du Pont, commissary of the artillery, to send one cannon-shot among this *canaille:* he gave me a flat refusal, saying that all this sort of people was not worth to have powder wasted on them. Again I begged him to level the cannon, telling him, the more dead, the fewer enemies, which he did for my sake: and the shot killed fifteen or sixteen, and wounded many."

To demand the death of unsuspecting idlers enjoying themselves on the bank of a stream—is not very creditable to the author of the desire. In Paré's palliation it must be argued that he lived at a time when the Christian theology was supreme, and much was heard of the wrath of God, but naught of the Brotherhood of Man. Neither from the proudest cathedral nor from the humblest pulpit was the word Humanity ever uttered. To have shown mercy to an enemy would have been the super-miracle—more wondrous than the healing of the ear of Malchus. A vivid insight into the psychology of those days may be acquired by reading one of the most remarkable works in all literature—*The Memoirs of Benvenuto Cellini,* Written by Himself.

In the sixteenth century the Supernatural Spirits were a nuisance—though their frightened mortal centemporaries did not dare tell them so. But their fleshless arms interfered with all things, great and small. The sweetest cream they soured, the finest babies they gave fits; they withheld the rain when it was needed, and they darkened earth and sky with eclipses;

they whispered heresies into the ears of the devoutest priests, they stole into convents at night, lifted the blankets from the chastest beds, and made indecent proposals to the holy nuns, who have kindly filled volumes of sexual psychology with their erotic confessions. Bolted doors were of no avail, for unlike the humped camel, they could pass through the eye of a needle. They were omnipotent, omnipresent, omniscient. And most mortals feared them, for not everyone could be a Luther and lambaste them with ink-bottles.

Ambroise Paré was a superstitious man: he believed in astrology, spiritism, magic, witchcraft and the royal touch; he believed that devils sent diseases, and that saints cured them; he believed that at the command of General Joshua the celestial orbs stayed and changed their courses, that because of the prayer of Elijah it ceased to rain for three years and six months, that Jesus was born of a virgin without the aid of a male, and a host of similar notions which were once accepted in their literal interpretation by the shrewdest of mankind, but are now happily relegated to the unused encephalic ganglia of the intellectually fossilized.

In Paré's day, embryogenesis was little studied, and teratology as a science was unknown. Nevertheless monstrosities, single and double, representing various degrees of congenital malformation, were known to exist, and an explanation was needed. What was the cause, they asked, of the birth of these abnormal beings—double-headed like Janus, one-eyed like Polyphemus, with webbed toes and fingers, with seven nipples, without limbs, with both sets of genitals, with three legs, with a cleft face, with features of a pig or dog, with osseous junctions joining two monsters together? According to some, these monsters were the offsprings of women and the devil; according to others, they were the result of sodomy. Ambroise Paré did not favor the first view, and argues thus (quoting from the old English translation of 1634): "It is much less credible that Divells can copulate with women, for they are of an absolute spiritous nature, but blood and flesh are necessary for the generation of man. What naturall reason can allow that the incorporeall Divells can love corporeall women? And how can we thinke that they can generate, who want the instruments of generation? How can they who neither eate nor drinke be said to swell with seed?" Paré, however, accepted the second explanation. "Therefore," wrote he, "in times past there have been some who nothing fearing the Deity, neither Law nor themselves, that is their soule, have so abjected and prostrated themselves, that they have thought themselves nothing different from beasts: wherefore Atheists, Sodomites, Outlawes, forgetfull of their own excellency and divinity, and transformed by filthy lust, have not doubted to have filthy and abhominable copulation with beasts. This so great, so horrid a crime, for whose expiation all the fires in the world are not sufficient, though they, too maliciously crafty, have concealed, and the conscious beasts could not utter, yet the generated mis-shapen issue hath abundantly spoken and declared, by the unspeakable power of God, the revenger and punisher of such impious and horrible actions. For of this various and promiscuous confusion of seedes of different kinde, monsters have been generated and borne, who have beene partly men and partly beasts."

The men of Paré's day were no wiser in regard to the plague. Listen again to Paré: "The plague is a disease coming of the wrath of God, furious, sudden, swift, monstrous, dreadful, contagious, terrible, called by Galen a wild beast, savage and most cruel; the mortal enemy of the life of men and of diverse sorts of beasts, plants and trees. . . . It is a thing established among true Christians, to whom the Eternal has revealed the secrets of his wisdom, that the plague and other diseases common among men, comes from the hand of God, as the prophet teaches us: Shall there be evil in the city and the Lord had not done it? . . . So let us be agreed that the plague, and other dangerous maladies are evidence of the wrath of God against the sins, idolatries, and superstitions, which reign over the earth: as even a profane author is compelled to confess that there is something divine in diseases." The reader may be interested to know that the "profane author" in this case is no other than Hippocrates.

Paré himself witnessed a plague and described its ravages: "And what is worse, in these field-huts there was that sight of the father and the mother grievously ill, not able to help their child, and they saw it smothered and bitten by wasps, and the mother to save it got up and then fell dead between her child and her husband. Again, he who has vassals, serfs or servants, is deserted by them: they turn their backs, and none dare go to him: even the father abandons his child, and the child his father: the husband his wife, and the wife her husband: the brother his sister, and the sister her brother: and those whom you think your nearest and truest friends abandon you now in the horror and peril of this disease. How many poor women, great with child, have been deserted and left to travail all alone, on mere suspicion, though they had no trace of the plague about them—for every sort of illness, in time of plague is feared—and so the mother and the child have died together. I found on the breasts of a woman dead of the plague, her baby still sucking the deadly poison that was soon to kill it like its own mother. Others, when the plague fell on them, were so afraid to die that they applied red-hot irons to the swelling, burning their own flesh, if by any means they might escape: others, in hope of cure, tore it out with pincers. Some in the heat and frenzy of the disease have thrown themselves into the fire, others into wells, others into rivers: men have hurled themselves out of windows, or have dashed their heads against the wall, till their brains came out, as I have seen: others have put an end to themselves with a dagger or a knife."

Yet, strange to say, Ambroise Paré thought the God who sent the plague was the Lord of Love.

No more can dreadful words like the above be written. No more can a devastating epidemic strike terror to the heart of a civilized nation, and wipe out a million inhabitants at a blow. In 1897, the same year that Stephen Paget published his *Life of Ambroise Paré,* the preventive treatment of the bubonic plague was discovered! No more do we quake and shudder in superstitious awe. Never again will a plague stalk like a ravishing fiend through Europe or America. We have given the plague its *congé,* and it can never return.

Ah, how much the world owes to medical science, and how little it realizes its obligations!

Paré was glad to get home from the wars. Thirty years of battle were quite enough, and it was a pleasure for the military surgeon to be again at Paris—sitting at ease before his own fireside, watching his little daughter at play, enjoying the society of his neglected wife. He could close his eyes lazily, and was in no danger of being startled by the bursting of the enemy's shell, or the groaning of an injured soldier. He could work all day on his books, and at night when his wife made the bed, he saw pillows unstained with blood. This was an unusual luxury for Ambroise, and he slept well.

Although Paré had been a barber-surgeon, and still knew no Latin—the *conditio sine quâ non* of a gentleman's education of those days—he gradually gained recognition as the foremost surgeon of his age. He was growing very distinguished, and his affairs were prosperous. He even dabbled in real estate successfully. Everyone, from royalty to the populace, loved him, and he found that spreading olive-branches of Peace offered a most pleasing shade. Never again did he wish to see fields bathed in blood. He had arrived at the age when rest is sweet, and comfort the great desideratum. He liked to walk calmly through the beloved streets of Paris, where "his face got to be as well known as the face of the king himself, and much more welcome."

Ambroise Paré served four kings, which led to the witty remark that the rulers of France transferred him to their successors as a legacy of the crown. One of the four was Henri II. This monarch married a woman who has left on the pages of history a little red blot that not all the bleaching power of Time can erase. She was the daughter of Lorenzo the Magnificent, the niece of Pope Clement VII, the wife of one French king, the mother of three, the mother-in-law of the loveliest of Scottish queens and the cruelest of Spanish kings, and her own name was Catherine de' Medici.

While her husband lived, she led a passive life, as her lord was under the sway of his mistress, Diana of Poitiers, but when he was killed by Count de Montgomery—whether accidentally or purposely is not known—the unchaste Diana was told to go, the son of Catherine became François II, and as he died at seventeen, having reigned seventeen months, seventeen days and seventeen hours, another son of Catherine became Charles IX, while she herself now held the reins of power in an unrelenting hand.

She knew Paré well, and as she was a good Catholic while he was a Huguenot, she once asked him, "M. Paré, do you believe you will be saved in the next world?"

He answered: "Surely madame; for I do what I can to be a good man in this world: and God is merciful, giving ear well to all languages, and alike satisfied whether one prays to him in French or in Latin." Evidently, Paré gave God credit for being an accomplished linguist.

Even in times of peace there can be excitement, and one day Ambroise was sent for—and told to hurry. He found that his patron Admiral Coligny, after leaving the Louvre and engaged in reading a letter, had been shot from a window—with the result that his left arm was wounded, and two fingers on his right hand broken. Paré attended to the wound and cut off the broken fingers. That Coligny was one of the most upright men of a dishonest age, all French historians agree. But Coligny was the leader of the Huguenots, and therefore every Catholic was his enemy. At two o'clock King Charles IX, and the Queen-Mother Catherine de' Medici, came to visit the Admiral—and Gaspard de Coligny saw his murderer. Over a hundred of Coligny's friends were in the apartments—but they allowed the cause of the hugest massacre in history to depart unharmed.

At midnight a noise was heard on the stairs. Paré, who had remained with his patient, asked, "What is the meaning of this riot?"

A few moments later the door was burst open, and some servants of the Duke of Guise entered. One of them, named Behme, asked, "Art thou not the Admiral?"

"Young man," said Coligny, "thou comest against a wounded and an aged man. Thou'lt not shorten my life by much."

Behme plunged a tremendous boar-spear in his stomach, and then struck him on the head. "If it were but a man!" cried Coligny as he fell, "but 'tis a horse-boy."

From the court-yard below was heard the impatient voice of the Duke of Guise: "Behme! hast done?" For answer, the lifeless body of the nation's hero was thrown from the window. It fell at the feet of the waiting Duke, who kicked the bleeding corpse in the face.

It had begun—the flood of blood was loose—the greatest massacre in French history had its scarlet baptism. Thousands and thousands of Huguenots were murdered, the streets of Paris were overcrowded with corpses, the provinces were likewise full of bodies, and the waters of the Seine were red for days after. Never can the memory of this butchery be wiped out, never can the Massacre of Saint Bartholomew be forgotten. The blood that was shed that day refuses to dry.

After Catherine induced her son to consent to the butchery, the king desired to destroy every prominent Huguenot in France, with the single exception of Ambroise Paré. He commanded Paré to repair to his own chamber, and the king himself saw to it that no zealous Catholic harmed his surgeon. The king ordered him not to stir from his wardrobe, saying it was not reasonable that one who was able to be of service to a whole world, should be thus massacred. Ambroise Paré did not even protest against the murder of his compatriots—for in those days a king ruled by divine right and could commit no wrong.

How many were massacred? Who could count? The number does not matter; the important thing is to remember to what lengths theological bigotry can go. And behind it all loomed a humble religious woman who never missed mass—Catherine de' Medici. She who had asked Paré if he expected to be saved, instigated the Massacre of Saint Bartholomew.

The victress could not keep within her rooms. As some women love to walk among their roses, she now strolled among her corpses. She found pleasure in again visiting Coligny; this time he was hanging on a gibbet. The city after the massacre seemed to call her with an enticing voice—as far as the eye could reach it feasted on the carcasses of heretics. The sight of a man, naked as well as dead, brought to those pious lips a jest, vilely obscene. She had laid her plans craftily and well, she was amply satisfied. Niccolo Macchiavelli's diabolical treatise, *Del Principe,* had found its most brilliant exponent.

As for Ambroise Paré, he had seen more blood in one day at Paris than in his thirty years at the wars.

A few days after the massacre, the king said to Paré: "Now you really must be a Catholic."

"By God's light," answered Paré, "I think you must remember to have promised me never to ask me four things: never to return to my mother's womb, never to fight in a battle, never to leave your service, and never to go to mass."

"Ambroise," said the king, "I don't know what has come over me for the last two or three days, but I feel my mind and my body greatly excited, in fact, just as if I had a fever; meseems, every moment, just as much waking as sleeping, that those massacred corpses keep appearing to me with their faces all hideous and covered with blood. I wish the helpless and the innocent had not been included."

The young man should have gone to his mother—she felt no qualms. Truly, the fate of heretics was not calculated to disturb an orthodox conscience. When the tale of the crimson carnival was bruited abroad, the Pope rejoiced, the Duke of Alva laughed, and Philip II ordered all churches in Spain to peal forth pæans of praise, to ring out *Te Deum.* But two centuries later, Voltaire, whom all religionists abhor, wept a poem of pity. Modern Catholics have grown ashamed of the papal hilarity, and attempt to deny it, but—

The moving Finger writes—and having writ,
Moves on; nor all your piety and wit,
  Shall lure it back to cancel half a line,
Nor all your tears wash out a word of it.

So many thousands slaughtered, and all in vain. For one young Huguenot, a pupil of Coligny, narrowly escaping with his life, lived to become Henry of Navarre, and eighteen years after the massacre he led the Huguenot forces to victory over the Catholic League at the battle of Ivry, and later established the Edict of Nantes which proclaimed religious liberty throughout the land:

Oh, how our hearts were beating, when, at the dawn of day,
We saw the army of the League drawn out in long array;
With all its priest-led citizens, and all its rebel peers,
And Appenzel's stout infantry, and Egmont's Flemish spears,
There rode the brood of false Lorraine, the curses of our land,
And dark Mayenne was in the midst, a truncheon in his hand:
And as we looked on them, we thought of Seine's empurpled flood,
And good Coligny's hoary hair all dabbled with his blood;
And we cried unto the living God, who rules the fate of war,
To fight for his own holy name and Henry of Navarre.

. . . .

Hurrah! the foes are moving. Hark to the mingled din
Of fife, and steed, and trump, and drum, and roaring culverin!
The fiery Duke is pricking fast across St. André's plain,
With all the hireling chivalry of Guelders and Almayne.
Now by the lips of those ye love, fair gentlemen of France,
Charge for the golden lilies, now upon them with the lance!
A thousand spurs are striking deep, a thousand spears in rest,
A thousand knights are pressing close behind the snow-white crest;
And in they burst, and on they rushed, while, like a guiding star,
Amidst the thickest carnage blazed the helmet of Navarre.

Now, God be praised, the day is ours! Mayenne hath turned his rein,
D'Aumale hath cried for quarter, the Flemish Count is slain,
Their ranks are breaking like thin clouds before a Biscay gale;
The field is heaped with bleeding steeds, and flags and cloven mail;
And then we thought on vengeance, and all along our van,
Remember St. Bartholomew, was passed from man to man;
But out spake gentle Henry then, "No Frenchman is my foe;
Down, down with every foreigner, but let your brethren go."
Oh! was there ever such a knight in friendship or in war,
As our sovereign lord, King Henry, the soldier of Navarre.

After the battle, the gallant chieftain closed in upon Paris, and besieged the city. But the Catholics swore to die rather than submit to a Huguenot—and they kept their word. While the people were eating the filth that they picked from the gutter, devouring the bodies of the slain and chewing the bones of the dead, the priests put on armor and threatened to hang all who spoke of peace—and they kept their word.

But again there was one exception—Ambroise Paré was spared a second time. Stepping out from his house one day, the venerable surgeon found himself face to face with the leader of the League, the powerful Archbishop of Lyon. The prelate had intended to cross the Pont Saint Michel, but found his way blocked by a starving mass of moaning wretches.

"Monseigneur," cried Paré, "this poor people that now gather around you are dying of the cruel pains of famine, and they ask pity of you. For God's sake have pity on them if you wish God to have pity on you. By your high office, and by that power which we all know you possess, bring about peace for us, and give us a way of living, for the poor are now utterly helpless. Do you not see that all Paris is dying, because of the villains who prevent peace? Set your whole heart against them, Monseigneur; take in hand the cause of this desperate people, and God will bless you and repay you."

The astonished Archbishop returned no answer, but walked away. Ambroise Paré was an aged man, and within a few months was to take his departure from life. This is the last time that we see him upon the stage of history, but we are thankful for the glimpse which exhibits to us the military surgeon raising his voice aloud for peace.

But now let us look backward, and name the books he wrote, and briefly sum up his life work. In 1545 he published his first book on the advice of Sylvius, as we have already mentioned. It was dedicated to M. le Vicomte de Rohan. In 1550 he published *A Compendium of the Chief Facts of Anatomy,* which contained also a treatise on Obstetrics. The *Compendium* was written as the result of dissections made at the School of Medicine with Thierry de Hery, who was famous even at this early period as a "specialist in syphilis." This book, like the first, was dedicated to M. le Vicomte de Rohan. In 1551 appeared the Second Edition of his first book, this time with a dedication to the King. In 1561 he published *Wounds and Fractures of the Human Head.* It contained illustrations of the instruments and a portrait of Paré. It was probably occasioned by the death of Henri II, whose case it recounts at length. The dedicatee was Chapelin. This year saw also the publication of his *Universal Anatomy of the Human Body.* It contained Paré's portrait, and was written as the result of dissections at the School of Medicine with Rostaing Bignosc. It is very interesting to note that many of the illustrations were taken from Vesalius, whom, by the way, Paré had probably met at the death-bed of Henri II, for Philip had sent his great anatomist there. In 1568 was published Paré's *Ten Books of Surgery.* It contained portraits and illustrations, and was dedicated to the king. This year likewise saw the appearance of his *Treatise on the Plague, Smallpox, and Measles.* It contained also a short account of Leprosy. It was written at the request of Catherine de' Medici, and dedicated to Castellan. In 1572 he published *Two Books of Surgery.* No copy of this edition is known to be in existence. The next year he published also a surgical work, dedicated to M. le Duc d'Uzes. In 1582 he published *On Mummy and Unicorn,* in which he wisely and vigorously attacked these worthless drugs which were then supposed to be a panacea for all ills, a sort of forerunner of

Peruna. How Paré discovered they were humbugs is not known. Probably the mummy and the unicorn failed to cure his toothache. The book was dedicated to M. des Ursins. It will be noticed that the Dukes and Viscounts to whom Paré dedicated his books, though great guns in their day, are now not even toy-pistols. Oho, for the whirligig o' time!

Four editions of the Collected Works of Ambroise Paré appeared during his lifetime: in 1575, in 1579, in 1582, in 1585. The third edition was in Latin, the translator being Jacques Guillemeau. When the reactionary mummies who comprised the Paris Faculty heard that a Latin translation was made by one who was not a member of their body, they were sufficiently enlivened to meet in council and pass this resolution: "Since there is nobody but a member of the school who would know how to make the translation, it is disgraceful to leave it to over-presumptuous surgeons, incapable of writing a page of Latin." A committee was appointed, and it actually acted; within nine days it suggested a title for Paré's works, and savagely decreed that "any leaves of the book having upon them any other title but this, to be effaced, torn up, and kept for some vile purpose." But Paré only laughed at their confounded nonsense; for years he fought valiantly against the Faculty, and aimed many a shaft at its contemptible dean, Estienne Gourmelen:

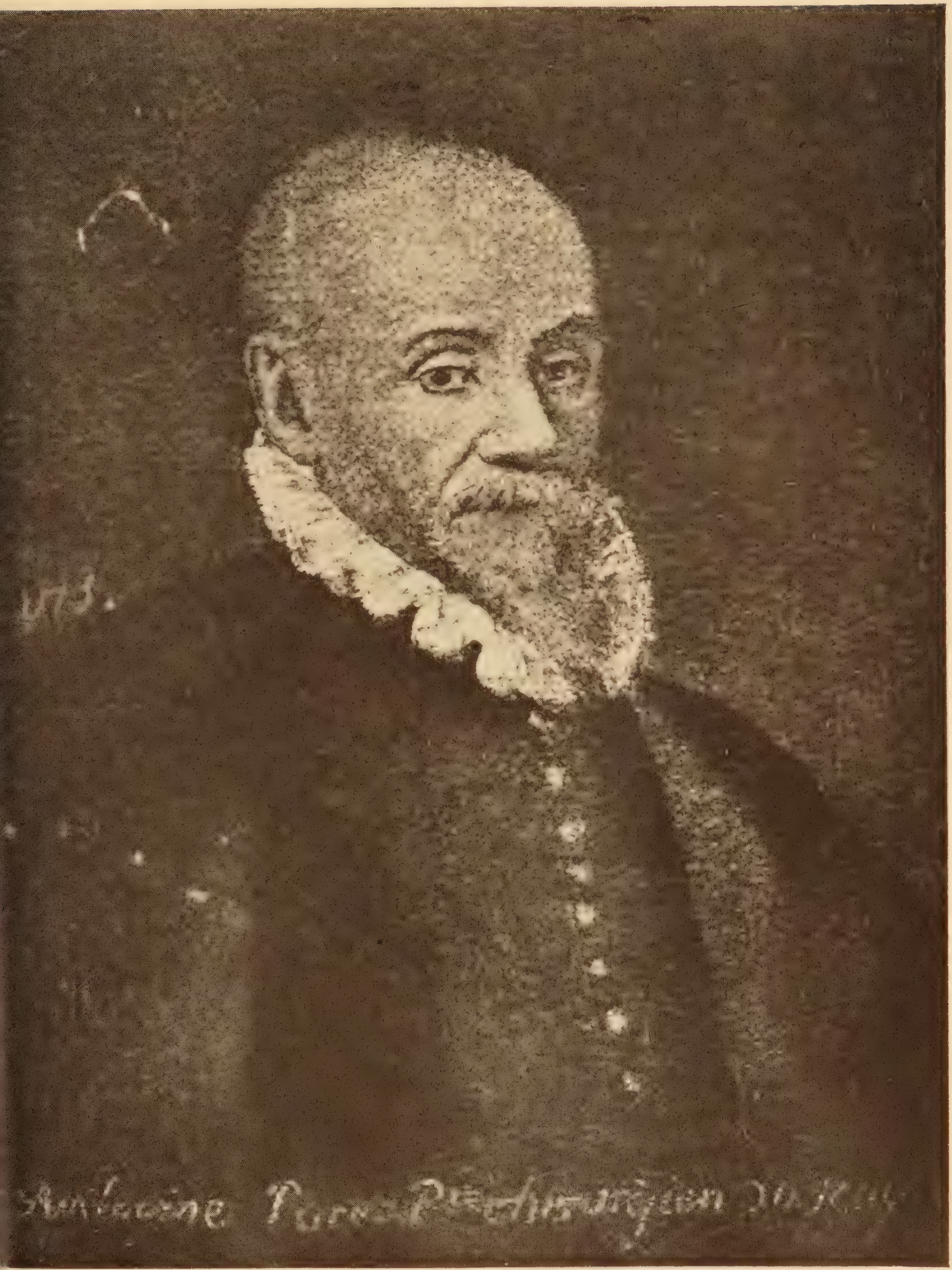
"Let me say," wrote Paré, "you are like a young lad of Low Brittany, who asked leave of his father to come to Paris. When he had come, the Organist of the Church of Our Lady found him at the Palace Gate, and took him to blow the organs, and there he was three years. He sees he can speak a little French, and goes home to his father, and tells him he speaks good French, and moreover knows how to play well on the organs: his father received him very joyfully, that he was so clever in a short time. He went to the Organist of their great church there, and prayed him to let his son play on the organs, so that he might know whether he were a skilful master as he said: which the Master Organist granted willingly. Being entered into the organs, he cast himself with a great leap at the bellows: the Master Organist bids him play, and he himself would blow the bellows. Then the young man tells him, I know nothing else but only how to play on the bellows. You too, *mon petit Maistre,* I think you know nothing else but how to chatter in a Chair; but as for me, I will play upon the keys, and make the organs sound."

In most respects Paré was ahead of the surgical knowledge of his day, but not in all. For instance, while his contemporary, Gaspardus Tagliacozzi, was developing the important art of Plastic Surgery, Paré pooh-poohed it, but many a man today considers rhinoplasty the most blessed of sciences.

The name of Paré has gone to the ends of the earth because of his advocacy of the ligature, but he was not its discoverer, for Hippocrates knew of it, and Hippocrates lived 460-357 B. C. "Say what you will," said Emerson to his philosophic readers, "you will find it all in Plato." Say what you will, let your laboratories turn out a new discovery every time a liquid filters through a funnel; announce a modern theory every time a patient has a fever; talk of clinical observation, rational therapeutics, dietetics, massage, sanitation, the value of rest, mental suggestion, anything you like—and you will find it all in Hippocrates.

Paré had reached the conclusion that since ligatures were applied to veins and arteries, there was no reason why they should not be equally used in amputations. At the siege of Danvilliers he determined to test his theory on a combatant whose leg was shattered by a ball from the fortress. Paré performed the amputation, but instead of searing the stump with a red-hot iron—and there were no anesthetics in those days—he employed the ligature, to the contentment of his patient who enthusiastically declared that he had got rid of his leg on very good terms. This is perhaps the most famous operation in the entire history of surgery.

Paré was a prominent adherent of massage—that delightful system which was known in the days of Homer, when the



PARÉ

PARÉ

beautiful women rubbed the weary limbs of the Grecian warriors.

Gentleness was not a conspicuous feature of the Dark Ages: in operating for hernia, hydrocele and sarcocele—although the Roman Celsus knew better—it was habitual for the mediæval surgeons to cut out either one or both testicles. Franco and Paré protested against this barbarity.

On the question of quiet, Paré has written so admirable a passage that it may be quoted for the benefit of Mrs. Isaac L. Rice and her worthy Anti-Noise Society: "The patient must be in a place of rest, as far from loud noise as possible, far from church bells, not near a farrier's, a cooper's, carpenter's, or armourer's shop, or the traffic of carts or the like, because noise increases pain, fever, and other complications."

Paré recommended for spinal disease two plates of iron, a posterior and an anterior one, fastened together in the form of a cross. It is thought that his corset was the earliest splint intended to be worn for diseased spine.

Paré was among the first to demonstrate that gunshot wounds are not poisonous, and he held that the air itself is beneficial rather than deleterious to the injury, but that it was the *miasms* in the air which often converted hospitals of the sick into morgues of the dead.

Paré was eminent as a syphilologist: he employed the speculum for examining vaginal and uterine venereal affections, discussed the nature of syphilitic bubo, and made the first detailed communications of hereditary syphilis.

Paré advanced the art of obstetrics to a considerable extent, wrote on the subject, and restored the podalic version. In this reform of midwifery, his pupil and son-in-law, Jacques Gillemeau, was associated with him and won considerable fame.

The Leaning Tower of Pisa is secure, but the life of man passes away in a night. Only a short time ago we began to write the first pages of this sketch, and the medical historian J. H. Baas was in the land of the living; now we are approaching the end of the essay, and Baas has already joined the great physicians whose deeds he chronicled. But on the bookshelf still remains his *History of Medicine.* This is what he wrote of the achievements of Ambroise Paré:

> He discarded the frequent dressing of ulcers, and castration in the so-called radical operation for hernia. He performed herniotomy in strangulated herniæ (most probably only at the suggestion of Franco), though this operation was often performed too in his day by itinerant herniotomists. He was the first surgeon to habitually employ trusses, though this instrument was already known to antiquity. Paré also taught how to recognize induration of the prostate and fracture of the neck of the femur. He introduced the operation of staphyloplasty and an improved method of trepanning with the crown trepan, and invented numerous instruments including feeding bottles for artificial nourishment. He performed bronchotomy, and employed the ligature in the treatment of fistula in ano; healed wounds of the nerves; circumscribed the employment of the actual cautery, particularly in operations for cancer of the breast; revived the operation for hare-lip with the figure of 8 suture, in which he was the first to follow the Arabians and Pfolspeundt; was the first to perform direct excision of the so-called loose cartilages in the joints, and was also acquainted with abscesses of the liver resulting from injuries of the head. Paré likewise improved the medico-legal doctrine of mortal wounds, practiced amputation of the leg at the point of election, and taught version by the feet.

It was the custom in Paré's day for members of the healing art to keep secret all their discoveries. Paré did not follow these egotistical ethics, saying the "light of a candle will not diminish, no matter how many come to light their torches by it." In fact, he had a passion for publishing, a naïve delight in announcing his newly-acquired knowledge. On one occasion he got a remedy from a quack, and gave for it enough velvet to make a pair of breeches, and a promise of secrecy. Paré soon published the prescription, and argued as follows: "And if any should urge that I have broken my promise to this alchymist, I answer that since he had sold it to me it was mine; and anyhow I think I have done him no wrong; on the contrary, he and I between us have conferred a great benefit on the public." Such a passage exhibits old Ambroise Paré in all his childish sweetness and simplicity, but it is evident that he never studied the law of contracts.

Some geniuses are so abnormally modest that though often over-appreciative concerning the works of others, it is impossible for them to realize the value of their own accomplishments. However, not many great men are thus afflicted. Merit and Modesty are not such inseparable twins as is often supposed. Ennius announced, "Let no one weep for me, or celebrate my funeral with mourning, for I still live as I pass to and fro through the mouths of men"; while even Ovid can hardly be accused of literary diffidence when he proclaims, "I have completed a work which neither the anger of Jove, nor fire, nor steel, nor consuming time will be able to destroy. I shall be raised immortal above the lofty stars, and indelible shall be my name. I shall be read by the lips of nations, and throughout all ages shall I survive in fame."

Paré was not one of those who minimized the results of their own labors. "God is my witness," he says, "and men are not ignorant of it, that I have labored more than forty years to throw light on the art of surgery and to bring it to perfection. And in this labor I have striven so hard to attain my end, that the ancients have naught wherein to excel us, save the discovery of first principles: and posterity will not be able to surpass us (be it said without malice or offense) save by some additions, such as are easily made to things already discovered."

Truly a bold prophecy, which we must challenge. Let us look at it fifty years after it was made: is it true? Yes, true. One hundred years later—and the proud words cannot be gainsaid. Still fifty years, and still the prediction cannot be controverted. Two hundred years pass—what now? Bravo, Paré, after two centuries to be still in the van! Another fifty years roll by,—what then? What then?—why, antiseptics and anesthetics are discovered, and Paré's boast is utterly wiped out. Scratch out his passage with a triumphant hand. We surpass him a thousand times and more! That which he never even dreamed of in his most buoyant mood has been accomplished in reality.

Ambroise Paré is no longer on the skirmish-line of surgery, fighting the advance battle for the alleviation of suffering. But though his children have gone so far beyond him, they follow the trail that he broadened and blazed, and Ambroise Paré ever remains the beloved Father of Modern Surgery.

(1596–1650)

RENÉ DESCARTES

I speak of René Descartes, of whom the least that can be said is, that he effected a revolution more decisive than has ever been brought about by any other single mind. . . . And although he was constantly engaged in those lofty inquiries into the nature of the human mind, which can never be studied without wonder, I had almost said can never be read without awe, he combined with them a long course of laborious experiment upon the animal frame, which raised him to the highest rank among the anatomists of his time. . . . He deserves the gratitude of posterity, not so much on account of what he built up, as on account of what he pulled down. His life was one great and successful warfare against the prejudices and traditions of men. He was great as a creator, but he was far greater as a destroyer.

H. T. Buckle.

He swayed not only his followers but his opponents for a whole century; and he gave to certain sciences, especially to optics, to physiology, and to physical astronomy, an impulse which has never been exhausted. . . . In every department of his thinking—in his first philosophy, his theology, his physics, his psychology, his physiology—Descartes sowed the dragons' teeth from which sprang hosts of armed men, to join in an intellectual conflict, internecine, let us trust, to their many errors and prejudices, but fraught with new life and energy to the intellectual progress of Europe.

J. P. Mahaffy.

I mean, that if you lay hold of any characteristic product of modern ways of thinking, either in the region of philosophy, or in that of science, you find the spirit of that thought, if not its form, to have been present in the mind of the great Frenchman. . . . Descartes took an undisputed place, not only among the chiefs of philosophy, but amongst the greatest and most original of mathematicians; while, in my belief, he is no less certainly entitled to the rank of a great and original physiologist; inasmuch as he did for the physiology of motion and sensation that which Harvey had done for the circulation of the blood, and opened up that road to the mechanical theory of these processes, which has been followed by all his successors.

T. H. Huxley.

VIII

RENÉ DESCARTES

After a long absence, the younger son returned to his father's house at Rennes in Brittany. He had passed through adventures in many lands, and was pregnant with impressions struggling to be born, yet in the presence of his family he remained silent. His father embraced him, and called him his "little philosopher," as he did in the early days when this frail child—the last offspring of a dying mother—first exhibited his precocious inquisitiveness. But then he had been so pale and coughed so constantly—and a dry cough it was too—that the doctors predicted he would never reach puberty. So instead of being forced early into the schools, he was permitted to grow up in the pleasant gardens of southern Touraine, where a careful nurse watched over him, and a squint-eyed little girl played with him. The sickly lad overcame his cough, studied under the Jesuits at La Flèche, then went on his travels, and here he was, a man of the world.

Between father and this son, there was affection, but not understanding: they thought other thoughts, and while they lived under the same roof, they dwelt in different spheres. In Holland, where the boy had served under Maurice of Nassau—not because the prince was a great general, but because he was a great engineer—the boy had seen a mathematical challenge publicly placarded. It was in Flemish, and being unfamiliar with the language, he requested a bystander to translate the problem for him. The stranger turned the Dutch phrases into Latin, and then ironically suggested that his inquirer—who was in soldier's uniform—should find the answer. The young Frenchman promised he would, but perhaps was a trifle awe-struck to learn that he had been addressing the eminent mathematical philosopher, Isaac Beeckman, principal of the College of Dort. But the next day he brought Beeckman the solution of the problem, and the principal introduced him to several Flemish mathematicians, among whom he soon became an acknowledged master. Should he relate these triumphs to his father? He could not, for though the old man might smile indulgently, he would rather hear of his son's progress in horsemanship and fencing—these being pursuits more becoming a French *gentilhomme* who belonged to the *demi-noblesse de la robe.*

Across the table, his elder brother glowered at him with undisguised hostility. Once they had lain in the same womb, but now they were miles apart. While the elder brother had been attending to his landed estates, the younger had passed through his great mental crisis: on the eve of St. Martin's day, 1619, meditating alone in his warm room at Neuburg, he "was filled with enthusiasm, and discovered the foundations of a marvelous science"—the application of algebra to geometry. Agitated and exalted, "comparing the mysteries of nature with the laws of mathematics, he dared to hope that the secrets of both could be unlocked with the same key." An intellectual revolution took place in his room that day, but if he dared to speak of it to his elder brother—who was following in his father's footsteps as counselor in the parliament of Rennes—he would be met by the retort that he was disgracing the family origin by indulging in such speculations and consorting with men who studied philosophy and wrote books and did not possess sufficient money to purchase a commission in the government. The sister had little to say, but she sympathized with the attitude of the elder brother. Therefore the young doubter could not explain that he had renounced Aristotle and the instruction taught in schools, and had determined to examine the principles of human knowledge anew. The mind of the sister did not extend beyond her drawing-room—but the mind of her younger brother embraced the universe, and extended its horizon.

So the youthful René Descartes, a stranger in his own family, again wandered away from the fold. He had already seen Paris, Breda, Neuburg, and journeyed through Bohemia, Hungary, Moravia, Poland, Pomerania, Brandenburg, Holstein, and Belgium; in Friesland, his travels nearly ended, for the hired boatmen, never imagining that a foreign gentleman understood their dialect, openly decided to throw him and his valet overboard, and divide the baggage among themselves, but Descartes drew his sword and uttered a few remarks which saved himself, his valet, and his baggage. Had it not been for his knowledge of Frisian—and his sword—modern philosophy would have had another history. Descartes now explored the Alps, and proceeded to Italy, visiting Venice, Rome and Florence, then returned to his native country, and resided for a few years in Paris.

During this period Descartes published nothing, but in Paris he associated with an inquiring circle of friends, and grew in intellectual stature. Many men have found it arduous to follow philosophy because of their poverty, but Descartes found it difficult because of his social position. Being a nobleman, it was incumbent upon him to play cards, dance, attend court functions, indulge in intrigue, beget illegitimate children, curse the populace, uphold the established religion, and eat and drink to excess. Descartes sometimes attempted to evade these duties, but with only temporary success. On one occasion he disappeared for several days, but an idle busybody named Le Vasseur, having spied the philosopher's valet in the street, followed him to the house where Descartes was hiding. Entering unbidden, Le Vasseur looked through the half-open door and detected Descartes in bed—although it was eleven in the morning. Paper was before him, and presently Descartes raised himself to write, then lay down again to meditate. This was not the first time that his work was thus interrupted, and Descartes was wise enough to realize that if he expected to write a flourishing Finis to his treatises, it would be necessary for him to relinquish the *aristocratie:* not in an atmosphere of debauchery and viciousness, but only in exile and solitude could the new system arise.

In the spring of 1629, a Frenchman whose sword-belt, silk hose and valet proclaimed his station in life, became a resident of Amsterdam. Several letters which had been forwarded to him, expressed astonishment at his unaccountable resolution to forsake his country and renounce his friends. But he seemed content with his self-imposed expatriation, and a few years afterward, in an epistle whose style was inspired by the circumstance that it was addressed to Jean Balzac—one of the most famous letter-writers of the period—Descartes extolled the advantages of living in Amsterdam:

> However well appointed a country house may be, it always wants innumerable conveniences only to be found in towns, and the very solitude which one expects is never to be found there in its real perfection. I will grant that you have there a river which can make the greatest talker dreamy, a valley so lonely that it can inspire you with transports of delight; but it can hardly happen that you will not also have a number of insignificant neighbors who come sometimes to intrude upon you, and whose visits are even more disagreeable than those you receive in Paris.
>
> Whereas in this great town where I now am, there being not a soul but myself who is not in business, everyone is so engrossed with his profits that I could live in it all my life without ever being seen by any one. I go to walk every day amid the Babel of a great thoroughfare with as much liberty and repose as you could find in your garden-alleys; and I consider the men whom I see just as I should the trees which you meet in your forests or the animals which pasture there; the very sound of their bustle does not interrupt my reveries more than the murmuring of a stream. If I reflect upon their actions, I receive from it the same pleasure which you have in watching the peasants who till your fields, for I see that all their travail helps to adorn the place of my dwelling, and makes me to want nothing there. If there be pleasure in seeing the fruit growing in your orchards, and its abundance before your eyes, think you there is not as much in seeing the vessels arrive

which bring us in abundance all the produce of the Indies and all that is rare in Europe? What other place could you choose in all the world where all the comforts of life and all the curiosities which can be desired are so easy to find as here? What other country where you can enjoy such perfect liberty, where you can sleep with more security, where there are always armies on foot for the purpose of protecting us, where poisoning, treacheries, calumnies are less known, and where there has survived more of the innocence of our ancestors? I do not know how you can be so fond of the air of Italy, with which you so often inhale pestilence, and where at all times the heat of the day is insupportable, the cool of the evening unwholesome, and where the darkness of the night covers thefts and murders? But if you fear the winters of the north, tell me what shades, what fan, what fountains can so well protect you at Rome from the discomforts of heat, as a stove and a good fire can here keep you from feeling cold.

Descartes frequently explained why he had adopted Holland as his country, but—as often happens—he carefully avoided all mention of his real motive. Seventeenth century Holland, although at times distracted by its own theological rancors, offered a refuge to foreigners who fled from the inquisitors of Spain and Italy, the Jesuits of France, and the Calvinists of Geneva. So Descartes' actual reason for quitting France is obvious enough, for while he professed loyalty to his king and submission to his church, he preferred to be out of the reach of both.

During his twenty years in Holland, Descartes chose various towns for his residence, and sent the address only to Marin Mersenne—the Cartesian ambassador to the republic of philosophy. Descartes and Mersenne first met as school-boys at La Flèche, and their lifelong intimacy is one of the classics of friendship. Mersenne was the Henry Oldenburg of Paris—he made few discoveries himself, but he was sponsor to most of the discoveries made in Paris. He mapped out work for others, and spurred on his laggard comrades to activity; a discouraged and vacillating investigator found in Mersenne a genial and stimulating counselor: he would coax out the hesitant doctrines and refer to them in one of his own treatises—conspicuously mentioning the originator—thereby quickening the publication of the new theories.

Mersenne's fidelity to Descartes never wavered, but he was on such cordial terms with Descartes' enemies that one of the worst—Voetius—made the mistake of appealing to him for help in overthrowing the unbelieving Frenchman. Mersenne was a father of the Minim Friars, and in spite of his devotion to the great doubter, his own orthodoxy was above suspicion. Mersenne wrote much on theology and philosophy, and in later years published several physico-mathematical tracts, but now he lives chiefly in the biographies of his illustrious friend.

In Paris, Descartes had begun writing some treatises, and it was expected that after he was fairly settled in Holland, these manuscripts would be prepared for publication. But Descartes explained to Mersenne that while working at them he had gained a little more knowledge than he had when commencing, and wishing to accommodate himself to the growth of this knowledge, he was compelled to make a new project larger than the first—as if a man had commenced a building to dwell in, and acquired meanwhile unexpected riches, so that the building he had commenced was too small for his altered condition. Such a man, continued Descartes, would not be blamed if he began again a new building suitable to his fortune.

Unlike many famous thinkers, Descartes was not an indefatigable worker, forever writing with never-tiring pen. Possessing neither strength nor inclination for unremitting toil, he asserted that an adequate amount of idleness was essential for the production of original work—and his practice followed his precepts. Descartes never rose early to prosecute his studies; while all the world was at its task, the philosopher slept; upon awakening, late in the morning, he still remained in his bed, meditating and writing, until about noon. In that bed Aristotle was vanquished, and ancient systems overthrown, and modern philosophy was born. Descartes was undersized, feeble-voiced and sallow-faced, but his pillow was a throne whence issued dicta which changed the intellectual aspects of the seventeenth century.

It was not until 1633, after further studies in metaphysics and astronomy, and researches in anatomy and chemistry, that Descartes' "new building," entitled *The World,* was completed. Before sending the manuscript to the printer, he inquired for a copy of Galileo's recently-published volume on the same subject, in order to compare it with his own. But instead of the book, he received startling news: Galileo, for proclaiming the doctrine of the earth's motion, was condemned to severe punishment by the Council of the Inquisition.

Descartes knew what occurred when the heralds of the Renaissance crossed the path of the Merciful Church. Campanella, after twenty-seven years of imprisonment by Spain, was convicted of heresy, and received an additional sentence from the Holy Inquisition; Pomponazzi, because he discarded certain superstitions, was judged guilty of impiety, his treatises were burnt, and he himself narrowly escaped the same fate. When Descartes was a growing child in the gardens of Touraine, there was a fire at Rome—and into its flames was cast the truth-seeker, Bruno; when Descartes was a young man, there was a fire in his own country, and a freethinker was there to feed it: for refusing to swallow the creed of the Infallible Church, Vanini was condemned to have his tongue cut out, to be strangled at the stake, and then burnt to ashes—and not a jot of this sentence was abated by the gentle lambs of organized theology. Descartes thought of these things, and trembled. When the ardent Dolet, for rejecting the conclusions of his contemporaries, was marched to the stake to be tortured and executed, he punned a pentameter on his name—*Non dolet ipse Dolet, sed pia turba dolet.* But the martyr-stuff was not in Descartes, and in alarm he wrote to Mersenne:

> I could hardly have believed that an Italian, and in favor with the Pope, as I hear, could be considered criminal for nothing else

> than for seeking to establish the earth's motion, though I know it has formerly been censured by some cardinals. But I thought I had heard that since then it was constantly being taught, even at Rome; and I confess that if the opinion of the earth's movement is false, all the foundations of my philosophy are so also, because it is demonstrated clearly by them. It is so bound up with every part of my treatise, that I could not sever it without making the remainder faulty, and although I consider all my conclusions based on very certain and clear demonstrations, I would not for all the world sustain them against the authority of the Church.

The careful Copernicus, realizing that his system of astronomy differed materially from that of Joshua—the doughty Jewish general who commanded the sun to stand still—declined for years to publish his manuscripts, and a printed copy of the book which "changed man's outlook on the universe," did not reach the author until he lay upon his death-bed—beyond the power of the Church. But Descartes was even more cautious than the Polish scientist, and as long as he lived, his *World* never ventured near a printing-press.

Putting aside *The World*, Descartes assured his friends and himself that he would never print anything, but the itch of authorship proved too strong, and on the eighth of June, 1637, when he was in his forty-first year—at which age John Mayow had long been dead—appeared his first quarto, *Discourse on Method.* This work was followed, four years later, by *Meditations,* which in turn was followed, after a three years' interval, by the *Principles of Philosophy.*

From these three volumes arose whole libraries in support and in refutation of Cartesianism, but we need not now examine Descartes' syllogisms, logic, a priori hypotheses, and criteria of truth. His chief merit is that he swept away the absurdities accumulated during centuries of mental sloth—a dwarf performed the task of a Hercules—and in his reconstruction of human knowledge, began with the tenet of universal doubt. "When I set forth in the pursuit of truth," said Descartes, "I found that the best way was to reject everything

I had hitherto been taught; I therefore, will occupy myself freely and earnestly in effecting a general destruction of all my old opinions." The easy path of faith leads to the ancient pit of error, but the hard road of doubt brings the inquirer to the gates of truth. Of course, on his arduous journey, Descartes could not divest himself of all ancient prejudices but at every step he preached the principles of free inquiry, of the value of experimentation, and of the rejection of authority.

According to Descartes, all propositions are involved in doubt, and admit of two opposite opinions. To hold such beliefs in the seventeenth century was to invite a religious funeral, so Descartes carefully explained that his unbelief extended only to mundane knowledge and not to revelation. But even his science had to be sneaked in by the back door. Since the Church refused to let the earth move, Descartes agreed that it did not move, but explained that it was like a passenger in a vehicle who was himself stationary, but was nevertheless carried along by the surrounding motion. To such base subterfuges was one of the greatest of philosophers compelled to resort in order to expound a doctrine which to-day enters into the curriculum of every schoolchild.

In spite of Descartes' protestations that his skepticism was limited to philosophical problems, the theologians were disturbed. With their keen noses for heresy, they perceived, justly enough, that if men commenced by doubting the current scholasticism, they would end by doubting the current faith. The battle was on, and the doctrines of Descartes were assailed by Jesuits and Calvinists—which is not in any way strange, for although much blood has been shed in the wars of religion, there is no essential difference between Protestant and Papist, and the two sects have always combined in their warfare against rationalism. The scientific spirit was as abhorrent to Luther as to Loyola.

Holland—whose heretical blood had been so freely shed by the pitiless Alva—was less fanatical than the Latin countries, but had not wholly emancipated itself from the odium theologicum. For advocating toleration in the Netherlands, young Grotius was condemned by his countrymen to lifelong imprisonment, and would either have perished or grown old in his cell, had he not been rescued by his wife's ingenuity. The Dutch Calvinists, under the leadership of Gysbertus Voetius, the professor of theology at Utrecht, opened a vicious campaign against Descartes, accusing him—of course—of the crime of freethought. Personalities were indulged in, and Voetius insinuated that Descartes was "a spreader of atheism, and the father of bastards," while Descartes referred to Voetius as "the son of a sutler, brought up among harlots and camp followers." Voetius was one of those theologians who calmly condemned millions of men, women and children to eternal hell-fire—and then sat down to enjoy his supper.

The controversy reached acrimonious heights, and as the adversaries of "the second Vanini"—as Descartes was named—gained in numbers, they were no longer content with libels and lampoons, but succeeded in passing a decree forbidding the doctrines of Descartes to be taught in the university, and it was pronounced unlawful for the booksellers to print or distribute his treatises. And there came a day—the thirteenth of June, 1643—when the city bells of Utrecht rang out, calling aloud for "a fugitive and criminal" to appear before the authorities—it was René Descartes, the benefactor of mankind who was thus arraigned, though his only crimes were ideas that enlightened the world. The public hangman of Utrecht was preparing to burn Descartes' books, and worse persecution would have followed, but Descartes, remembering he was a French nobleman, appealed for protection to the French ambassador; the case was thus laid before the Prince of Orange, and Utrecht received the hint to search for offenders in less influential quarters.

Descartes was particularly anxious to conciliate the powerful Order of Jesus, but that scholastic Jesuit, Father Bourdin, ferreting out the danger that lay concealed in the new teaching, launched an early broadside against Cartesianism. Descartes knew, from his schooldays at La Flèche, that Jesuits act only in concert, and that Bourdin's attack signified Jesuitical disapproval of their former pupil.

But Descartes was not a solitary figure, standing alone against the intrenched ecclesiasticism of the age. From Roger Bacon's prison-cell, and from Telesio's books which the cardinals condemned, had fallen seeds nurtured by Pompanazzi and Campanelli, fostered by the wit of Montaigne and the laughter of Rabelais, watered by the tears of Galileo and Kepler, and fructified by the blood of Paleario and Bruno. In the seventeenth century the Renaissance was in full bloom, and everywhere—except in Spain, where the Inquisition had put an effectual end to all intellectual activity—defenders of Descartes arose, and preached his text with enthusiasm. When Cartesianism was ejected from the colleges, several teachers resigned their posts, and with the ardency of apostles spread the new gospel throughout Europe.

In spite of Papist-Protestant combination, in spite of parliamentary condemnation and royal prohibition, Cartesianism could not be uprooted. At the young university of Breda, it was taught with fervor. The French Academy of Sciences, from the day that its doors opened, was steeped in Cartesianism. Mme. de Grignan, the Duchesse de Maine, the Marquise de Sable, and other ladies of high station, opened their salons for expositions of the Cartesian philosophy, and revealed such knowledge of it that they furnished material for Molière's *Femmes Savantes.* Mme. de Sévigné, the immortal gossip of the age, speaks of the Cartesian system as something which must be learnt for social purposes, like dancing and card-playing. Moreover, many theologians whose orthodoxy was never impugned, accepted—with certain expurgations—the new system, and aided in its dissemination. It influenced the most advanced thinkers of the succeeding age: Ludwig Meyer, the friend and translator of Spinoza; Balthasar Bekker, whose *World Bewitched* not only attacked the widespread belief in witchcraft, but even dared to question the existence of the devil; the physician-philosopher, John Locke, whose mind was first stirred to enthusiasm by the books of the French philosopher; and Leibnitz, who spoke of Cartesianism as the antechamber of truth. Molyneux, of Dublin, in the preface to his translation of Descartes, compared his six *Meditations* to the six days of creation, "and certainly next to the creation of all things out of nothing, the restoration of truth out of errors is the most divine work; so that (with reverence be it spoken) the incomparable Descartes does hereby deserve as it were the name of a Creator." Descartes, however, was not compelled to wait for posthumous fame and praise; in his lifetime he had the felicity to be regarded as a classic, and heard men speak of him as the Archimedes of the age, the Hercules of science, the true Atlas of the universe.

As we turn the pages of history, we learn that the betrayers of humanity, the individuals who have heaped the most anguish on the human race, have been rewarded with the greatest power and honor: Torquemada, who burnt thousands of human beings, and robbed millions of their peace and possessions, himself reached a venerable age, and passed away surrounded by sovereigns; Alva, who counted that day lost in which he did not slaughter multitudes, whose victims crowded the graves of many nations, enjoyed the privilege of shedding blood until the end of his long career; that consummate villain, Louis XIV, who ruined his country by the revocation of the Edict of Nantes, was permitted, by man and nature, to remain on his throne, amid universal plaudits, for considerably over half a century.

As we turn these same pages, we also learn that the individuals who have uplifted the human race, have often been rewarded with poverty and persecution: Columbus, who gave a new world and a new impulse to mankind, was put in chains, which he kept in his room forever, "as relics and as memorials of the reward of my service"; Cervantes, one of the chief glories of the worst of nations, passed much of his time in prison, neglect, and destitution; Thomas More, one of the highest-minded Englishmen in the realm, solely because he refused to be corrupted by Henry VIII, was imprisoned and beheaded; Spinoza, a saintly figure, living alone and asking nothing from the world, but ever burning in his solitary study the lamp of rationalism and toleration, was pursued by obloquy, and even after his premature decease, men spoke of him "as if he were a dead dog"; Lessing, the champion of free criticism, whose pen widened and broadened the narrow creeds of his day, was pin-pricked a thousand times by theologic malice.

Descartes was more fortunate than these reformers; compared to their fate, his own was peaceful and prosperous. His books, in spite of the commotion they caused, were not successful financially—his publishers continually grumbled—but the money which he inherited enabled him to live in a manner suited to his tastes, and saved him from the necessity of getting up in the morning to earn a living by uncongenial work. Furthermore, his aristocratic birth, his gracious and polished demeanor, his contempt for the common people, his influential friends, added to his ability to dissemble and cringe, saved him from occupying a bed provided by the authorities.

M. de Sorbière, whom every one envied because he had nothing to do except to travel from country to country, visiting the foremost celebrities of each nation, has left us this glimpse of Descartes:

> I hurried to Eyndegeest, half a league from Leyden, as soon as I reached Holland, at the beginning of 1642. I there visited M. Descartes with much pleasure, and sought to profit by his conversation for the better understanding of his doctrine. I was delighted with the civility of this *gentilhomme,* his retreat, and his household. He was in a little château of fine situation, close to a great and fair university, three leagues from the Court, and hardly two hours from the sea.
>
> He had a sufficient staff of servants, all well chosen and comely people; a nice garden, with an orchard beyond it; and all around pastures, from which stood out many steeples of various heights, till in the far horizon they seemed mere points. He could go in

> a day by canal to Utrecht, Delft, Rotterdam, Dordrecht, Haarlem, or Amsterdam. He could spend half his day at The Hague, and return in the evening, making his excursion by the most beautiful road in the world, through meadows and houses of pleasance, then through a great wood bordering this village, which is not inferior to the fairest towns of Europe, and boasted at this time the residence of three Courts.
>
> That of the Prince of Orange was quite military, and brought together 2000 gentlemen in warlike array; the leathern collar, the orange scarf, the top-boots, and the sword were its principal features. That of the States-General was composed of deputies from the United Provinces, and of Burgomasters, who kept up the dignity of the aristocracy in their black velvet dress, their deep collars, and square cut beards. The Court of the Queen of Bohemia . . . might be compared to that of the Graces, where all the fashionable world of The Hague went almost daily, to pay their homage to the talent, virtue, and beauty of her four princesses, the eldest of whom had a fancy for the discourse of M. Descartes.

The princess to whom the garrulous M. de Sorbière referred, was Elizabeth, the favorite pupil of Descartes. In connection with Princess Elizabeth, we see Descartes in his worst light—the courtier leaking through the man, the sycophant overshadowing the philosopher. Not content with announcing that whereas the metaphysicians knew nothing of his mathematics, and the mathematicians knew nothing of his metaphysics, while Princess Elizabeth was the only one who understood both, Descartes was base enough to add that persons "of exalted birth have naturally more exalted capacities than are given to their inferiors."

Descartes and Elizabeth corresponded for years on philosophical and mathematical subjects, and Descartes dedicated to her his *Principles of Philosophy,* and wrote for her the treatise on the *Passions of the Mind.* Her brother, Prince Philip, also knew something about passions, for one day he stabbed a gentleman to death; her notorious mother, the beautiful "Queen of Hearts," accused her philosophic daughter of participation in this incident, and banished her from The Hague.

Elizabeth eventually became Abbess of the Herforden convent, which she conducted on the liberal principles of Descartes; the refugees of all religions were welcomed, and here the Princess sheltered the English Quakers, George Fox and William Penn. It is asserted that in her later years she grew more mystical, and regretted that she had ever spent on philosophy, the time that should have been devoted to true piety—just like a princess.

Descartes was wont to compare science to a tree, of which metaphysics was the root and physics the trunk, the three chief branches being mechanics, medicine, and morals—"the three applications of our knowledge to the outward world, to the human body, and to the conduct of life." Descartes' acute interest in medicine seems to have been the result of personal contact with the physician Regius, one of the most ardent of his disciples—afterwards his opponent—but in turning his attention to medical problems, Descartes was only following a well-established precedent, for at that time many mathematicians were physicians, and many physicians were mathematicians. If ever an aspirant for a Ph.D. is in search of a theme, we suggest an investigation of The Influence of Mathematics on Medicine. This influence survived to the eighteenth century, when the erudite English physician, Richard Mead—more than one of whose medical treatises was inspired by the mathematical discoveries of Newton—declared:

> It is very evident, that all other means of improving medicine have been found ineffectual, by the stand it was at for two thousand years, and that, since mathematicians have set themselves to the study of it, men already begin to talk so intelligibly and comprehensibly, even about abstruse matters, that it is to be hoped that mathematical learning will be the distinguishing mark of a physician and a quack.

It is dangerous for a philosopher to enter the domain of medicine—he is so apt to slip into quackery. Bishop Berkeley did not believe in matter, or in the higher mathematics—"because it led to freethinking"—but he did believe in tar-water. In his *Chain of Philosophical Reflections Concerning the Virtues of Tar-Water,* he proclaimed it a panacea, his chain of reasoning being that from the sunlight and air the pine-trees accumulate the vital elements of the universe and concentrate them in the tar which when imbibed by the human system proves capable of curing such diverse maladies as smallpox, consumption, syphilis, complaints of the bowels, ulcers and gravel. The doctors who protested against this universal remedy were suspected of being financially frightened, and their scoffs could not prevent the belief in tar-water from developing into a mania. While Berkeley's treatise was being reprinted and translated into many languages, barrels and barrels of tar-water were being consumed all over Europe, and especially in Great Britain, for Berkeley was a prophet in his own country. Testimonials poured in from all sides, and the Reverend Edward Young, the cheerful author of *Night Thoughts,* in alluding to the opponents of tar-water, wrote: "Now give me leave to say that this infidelity may possibly be as fatal to morbid bodies as other infidelity is to morbid souls." So Bishop Berkeley has his niche among the famous quacks.

Descartes made no efforts to add a universal drug to the materia medica, but he came perilously near folly by his plans for the indefinite prolongation of human life: on hearing that Mersenne was suffering from erysipelas, Descartes urged his friend to keep himself alive until he had completed his medical discoveries, and by throwing out hints that his treatise on medicine would point out the best method of "fighting the battle with nature," the philosopher raised extravagant expectations among his worshipers.

In this connection, Descartes was visited by the audacious Sir Kenelm Digby, the prince of impostors. Kenelm Digby was the son of a leading Gunpowder Plot conspirator, but in spite of his blotted escutcheon, his irresistible suavity won the favor of James I, who was suspicious of every one else. Being a moneyed gentleman with nothing to do, Digby was permitted by the king to become a pirate and steal the ships of foreign nations—and in due time he celebrated his birthday by a victory in the Levant. There are two ways for a poet to gain immortality: one is by writing verses which are very good, and one is by writing verses which are very bad. Ben Jonson, in his eulogy of Digby's naval accomplishment, employed the latter method:

> Witness his action done at Scanderoon
> Upon his birthday, the eleventh of June.

Alternately frowned upon and fêted by the court, dipping in the borderland of certain arts and sciences, changing his religion at convenient intervals, talking much and working little, talented and ill-balanced, learned and unreliable, killing a French nobleman for insulting Charles I, but fawning upon Cromwell during the protectorate, Digby is one of history's mountebanks. He married, secretly and suddenly, a lady more renowned for her beauty than for her virtue, and in order to preserve her good looks, he experimented upon his lovely Venetia, inventing various cosmetics, and finally feeding her upon the wine of vipers. She died mysteriously, and although the husband's lamentations were loud and violent, his enemies blamed the viper's wine.

Digby's association with the history of medicine—or rather, with the history of medical delusions—is due to his Powder of Sympathy, which miraculous drug he claimed he secured from a Carmelite monk, but no credence need be placed upon his statements, since he was a prodigious "teller of strange things," and his discourse was like a chapter out of Pliny. The sympathetic powder was applied, not to the wound, but to the weapon which caused the injury, or to a portion of the sufferer's garment. For example, the Duke of Buckingham's secretary had been so severely stabbed that death from gangrene was the doctors' prognosis, but Kenelm Digby came to the rescue. Asking for the secretary's blood-stained garter, he bathed it in a basin containing a solution of his sympathetic powder, and within an hour the secretary felt "an agreeable coolness," and was soon completely cured. Credulity writes testimonials for every fraud. Among the numerous laudatory letters which were sent to Digby, was one telling about a carpenter who had cut himself with an ax, and attempted a sympathetic cure by anointing the ax and hanging it upon a hook. The wound was progressing favorably, until one day it re-opened—because the ax had fallen from its hook. Madame de Sévigné pronounced the Powder of Sympathy "a perfectly divine remedy," but as she was almost equally enthusiastic about the therapeutic virtues of human urine, we may temper her ecstasy with judgment.

This Digby was the man who came to Descartes, importuning him to use his extraordinary knowledge for the purpose of increasing the span of human life; Descartes, ever susceptible to flattery, complacently answered that while he was not justified in promising to render man immortal, he was convinced that he could make us a race of Methuselahs.

But the scythe of death was not even blunted by Descartes, and he soon relinquished the attempt to vanquish the conqueror of all. His venture in this field does not affect his life-work—it simply takes its place among the absurdities of science, along with the archæus of Paracelsus, and Hobbes' ludicrous efforts to accomplish the quadrature of the circle—and so many others.

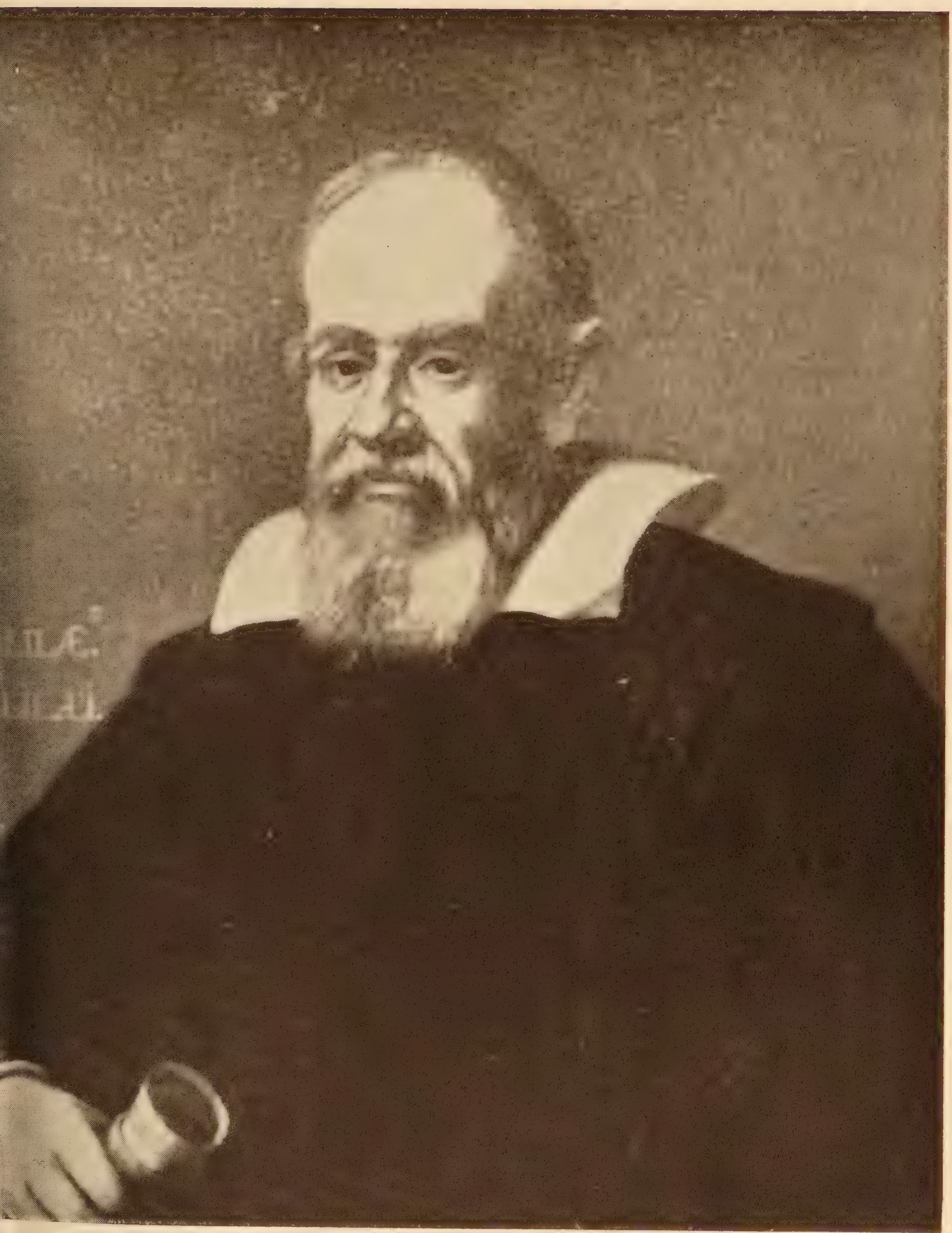
Descartes said, "If it be at all possible to ennoble mankind, it will be only through Medicine," but his primary interest, of course, was philosophy, and not medicine, and he studied the latter branch merely that he might apply to it his system of philosophy—just as the Arabian philosopher, Averroes, had done, centuries before. In order to complete his system of philosophy, it was necessary for Descartes to demonstrate that the mathematico-physical laws which govern the universe, govern also the human body; it was his object to prove that man was a machine, a skilful mechanism, all of whose processes, such as digestion and respiration, resulted from automatic and mechanical causes.

Descartes presented these views in his treatise on *Man,* which

DESCARTES.

FROM THE PICTURE BY FRANZ HALS IN THE LOUVRE.

AUTOTYPE



GALILEO

Portrait brought from Florence in 1661, now in the Bodleian.

WILLIAM HARVEY

NIELS STENSEN

is now regarded as the first text-book on physiology. The story is told that when a visitor asked Descartes where he kept his library, he drew aside a curtain, and pointing to some animals which he had been dissecting, he answered, "There is my library." But Descartes was too steeped in speculation to be successful in experimentation. He was too great a philosopher to be an equally great physiologist. The human body was waiting to be discovered in those days, and striplings like Bellini and Regner de Graaf wrote their young names on tubules and follicles, but Descartes' scalpel was not as keen as his logic.

Descartes accepted the new theory of the circulation of the blood—it was another proof that physical laws controlled the bodily machine—and he acknowledged that the merit of this discovery belongs to Harvey. It must have cost Descartes an effort to lay this wreath on the Englishman's head, for Descartes was chary of praise, and preferred to wear the laurels of priority himself. When Descartes looked at the earliest theorems of Huyghens, he predicted greatness for the future discoverer of the rings of Saturn, but as a rule, Descartes, although not as quarrelsome as Salmasius, belittled and disparaged his eminent contemporaries. He claimed he found little of value in the books of others, and when he journeyed through Florence, Galileo was there, but Descartes took particular pains to inform the public that he never saw Galileo and never learnt anything from him—in which respect Descartes differed from the violent-tempered Borelli who nevertheless traveled from Messina to the mainland to hear the voice of the father of physics. Harvey, however, not only aroused Descartes' intellectual admiration, but excited his personal curiosity, for in one of his letters, he asks:

> Do you not know in London, a celebrated physician named Harvey, author of a book *De motu cordis et circulatione sanguinis?* What sort of person is he? As to the motion of the heart he has said nothing not found in other books, and I do not quite approve of it; but as to the circulation of the blood, there he has his triumph and the honor of first discovering it, for which medicine owes

> him much. He promised some other treatises; I don't know whether he has printed them. It is such works which deserve being read, and not a quantity of big volumes which are mere waste of paper.

This note sounds something like Hobbes' reference to Harvey as "the only man I know that, conquering envy, hath established a new doctrine in his lifetime."

The fame of Descartes was European, and Harvey appreciated his favorable opinion, for in the second disquisition to that anatomical nuisance, John Riolan, Harvey speaks of "the ingenious and acute Descartes, whose honorable mention of my name demands my acknowledgments."

In one physiological instance, Descartes saw more clearly than Harvey, for the latter persistently refused to believe that Aselli had made a discovery, but Descartes, in his treatise on the *Formation of the Fetus,* mentioned "the white veins, called lacteals, which Aselli has recently discovered in the mesentery."

It is interesting to hear Stensen's estimate of Descartes as a physiologist, delivered in the days when the illustrious Dane still preferred the dissector's apron to the bishop's gown:

> Descartes was too clever in exposing the errors of current treatises on man to be willing to undertake the task of expounding the true structure of man. Therefore in his essay on *Man* he does not attempt such a delineation, but is content to describe a machine capable of performing all the functions of which man is capable. And in this sense we may affirm without exaggeration that Descartes bears the palm over all other philosophers in this matter. For he was the first who dared to explain all the functions of man, and especially of the brain, in a mechanical manner. Other authors described man; Descartes puts before us merely a machine, but by means of this he very clearly exposed the ignorance of others who have treated of man, and opened up for us a way by which to investigate the use of other parts of the body, though it may be difficult to do so with the same clearness and fidelity with which he proceeds in demonstrating the parts of his machine of man, a task which no man before him attempted.

Descartes once constructed a speaking figure which so frightened a superstitious captain that he threw it overboard, but Descartes would have admitted there was one difference between this machine and man—the latter mechanism, according to Descartes, was controlled by a rational soul lodged in the pineal gland. But Descartes did not admit that animals had a similar soul, his hypothesis being that animals are unconscious automata, possessing neither language, feeling, nor thought—a theory which led to monstrous results, for his followers were cruel to their domestic animals, "kicking about their dogs and dissecting their cats without mercy, laughing at any compassion for them, and calling their screams the noise of breaking machinery." Descartes could not believe that animals have souls, for he argued that if cats and dogs are immortal, the same principle must be extended to oysters and worms.

In this respect Descartes was distinctly behind some of his predecessors: Montaigne, who pointed out that there is more difference between the highest and lowest men than between men and brutes; and Charron, who after showing that animals have both reason and virtue, insisted, in modern language, that there are no breaks in nature.

It is indeed probable that we are automatons, with fate pulling all the strings—recent science rather confirms, than contradicts the view of Descartes—but Descartes' fundamental error lay in imagining an essential distinction between human and other animals.

In his *Dioptrica,* which formed one of the essays attached to his *Discourse on Method,* Descartes compared the eye to a camera obscura, and showed its accommodations to be due to the changes in the form of the lens. In his *Passions of the Mind* he opened up the field of reflex action by explaining the phenomenon of involuntary winking. His invention of analytical geometry, his undulatory theory of light, his investigation of figures of lenses causing rays to converge to a point, his discovery of Cartesian ovals, and of the law of refraction, make Descartes one of the founders of ophthalmology.

In his comparison of Descartes and Newton, Voltaire explained that Newton was not subject to the common frailties of mankind and had never approached a woman in a carnal manner, while Descartes evidently did not consider the passion of love derogatory to his character or his philosophy, for he had a daughter by his mistress. But even the incident to which Voltaire alludes cannot be regarded as a love-affair, for Descartes never makes the slightest mention of the mother, and his friends neither saw her nor heard her name. The child was born during the period in which Descartes was composing his treatise on the *Formation of the Fetus,* and it has been suggested that Descartes fathered her for scientific reasons only. Yet he learnt to love his little Franchine, and planned her future, but she did not survive the perils of childhood—and so the little spinet which her father constructed for her, remained silent. Descartes was not an amorous man; in fact, he was ungallant to the point of boorishness—which is unpardonable in a Frenchman. He seems to have been one of those males who "wish that Adam had died with all his ribs in his body," for he affirmed the three rarest things in the world are a good book, a perfect preacher, and a beautiful woman. As a wooer, he was no more ardent than Newton; a lady whom Descartes might have married—if she had been persistent enough—asserted that during his courtship he uttered epigrams like this: "There is no beauty equal to the beauty of truth."

Descartes reverenced the truth, but not as much as he reverenced a throne. No reward of philosophy could have given him such satisfaction as the receipt of a letter from Queen Christina of Sweden, requesting his opinion on the excesses of love and hate. He replied with avidity, thus gaining his second royal pupil, for the queen continued the correspondence. As Descartes rose in her favor, he resolved to play a game in politics—hoping that by Christina's intercession, Elizabeth's family would recover some of their former powers in the Palatinate. So he wrote to the Queen about his exiled Princess, enclosing copies of her letters, discoursing about her tribulations and virtues. Descartes was not the first man who tried to bring two of his lady-friends together—and there are men attempting the same futile thing to-day—but no successful case is on record.

Christina took not the slightest notice of Elizabeth, but grew more and more cordial to Descartes—and finally invited him to come and live in Sweden. It is difficult to determine what Descartes really felt when he perused this request, but at first he affected hesitation. He explained to his friend Chanut—the French ambassador through whose medium the Christina-Descartes correspondence had been conducted—that a man born in the gardens of Touraine, who had retired to a country where there was less honey than in the Promised Land, but perhaps more milk, could not readily consent to live in the home of bears, among rocks and ice. Then he wondered whether his reception by the Queen would not excite envy and unpleasantness. But Christina, with royal impatience, sent a ship and an admiral to fetch Descartes to Stockholm, and though this vessel was compelled to return without him, Christina eventually had her way, for the day came when the philosopher knelt before the Amazon of the North.

On Descartes' arrival in Stockholm, in October 1649, Christina was in her early twenties. She was the daughter of Gustavus Adolphus, and in her infancy had been exposed by that warrior to the sound of cannon, and the noise and fury of battle had entered her soul, for a more vigorous valkyr never sat upon a throne. She detested her own sex, and yet nothing enraged her more than the suggestion that she should marry. The great chancellor, Axel Oxenstjerna, could cope with even a Richelieu, but he trembled at the antics of the energetic Christina. Strange to say, in this young and imperious virgin the arts and sciences found an ardent patron: in spite of Sweden's poverty, Christina spent extravagant sums on books and manuscripts, and antiquities and curiosities. She admired famous men, and gathered around her so many sages that Stockholm compared itself to Athens. Of course, contemporary judgment is often faulty, and Christina was a royal and not an infallible judge, so it is not surprising that at times she welcomed the pretender as heartily as the thinker, and that in her crowded court the charlatan jostled the scientist.

Christina showed her good sense by permitting Descartes to absent himself from all court ceremonies, and she also showed her good health by requiring him to instruct her in philosophy at five o'clock in the morning. Even in sunny weather and in warmer climes, Descartes had never seen the world at five o'clock, but when the queen speaks, the courtier obeys. The winter of 1649–50 was of such severity that even the Swedes respected their blankets by night and firesides by day, but in the bleak dawn Descartes passed from his home to the Queen's palace. He composed a masque for the court, but evidently it was not another Comus, as his executors never published it—Voltaire says it was suppressed in honor to his memory. He prepared the rules, still extant, for an Academy of Sciences, which Christina wished to establish. As the climate visibly disagreed with him, the queen planned to make him a noble and bestow upon him a large estate in her southern and newly-annexed duchy of Bremen or Pomerania. It was no hardship for Christina to ennoble and enrich her favorites—a stroke of the pen, and it was done. In fact, she was so generous in this respect that Sweden was impoverished.

Descartes might have lived to enjoy these coming honors, but that lesson at five o'clock was fatal. His weak lungs could not withstand that harsh hour, and in February he lay upon a sick-bed, suffering from the same pulmonary complaint from which his friend Chanut was convalescing. Descartes had helped to nurse the ambassador back to health, and now the recovered patient became Descartes' nurse. Accident and misfortune met: the queen's chief physician, Reyer, a congenial countryman of Descartes, was out of the city, and Descartes found himself confronted by a Dutch doctor, named Weulles, who in the controversies in Holland had displayed a pronounced anti-Cartesian bias.

With such a physician, Descartes could not recover, for it is stated that "the very sight of this man set the patient beside himself, and . . . he told Weulles he would die the more peaceably if he would keep out of his sight." Venesection was then the curse of treatment—"a bloody Moloch," complained Van Helmont, "presides in the chairs of medicine,"—but Descartes' attitude was more enlightened than that of most of his contemporaries, and when an endeavor was made to bleed him, his cry rang through the death-room, "Gentlemen, spare the French blood." Later, upon the solicitation of Chanut, he permitted himself to be bled twice, but nature, which saved the ambassador, slew the philosopher. Before reaching his fifty-fourth birthday, Descartes passed out of the world—sacrificed to a royal caprice.

So Descartes, who thought to steal years from nature, himself died prematurely, but he was not one of those men "who leave the world with a mere Hic jacet." His mechanical philosophy was one of the dominating influences of his age. His apothegm, *I think, therefore I am,* is as deathless as Archimedes' *Give me a place to stand, and I will move the world,* or Bacon's *Knowledge is Power.* Such current phrases as Cartesian diver, Cartesian curve, Cartesian lens, Cartesian coördination, Cartesian oval, and several others, keep alive the name of this seventeenth century thinker.

Christina, with her usual impetuosity, determined to honor Descartes by burying him at the feet of Swedish kings, but the illustrious dust was eventually returned to its native soil. Yet had Descartes lain in Stockholm, Christina could not have mused long over his mausoleum, for in her twenty-eighth year, being vexed at the political suggestion that she acquire a husband, and being bored with what she termed the splendid slavery of royalty, she abdicated with great pomp—in male attire.

For the remaining thirty-five years of her life, she alternately amused and alarmed the nations. Repudiating the religion of her country, she espoused Catholicism, being rechristened Alexandra, and then spent much of her time in quarreling with popes and cardinals, and scolding Louis XIV for his persecution of Protestants. Although she had abandoned her throne voluntarily, she still claimed to be a sovereign wherever she went, and proved it by putting her major-domo to death, her only reason being that he had been guilty of high treason against her. However, it was not necessary for Christina to condescend to details, since a learned and lengthy defense of her crime was prepared by Leibnitz—one of the greatest of philosophers, and one of the greatest of sycophants.

Christina's diplomatic intrigues were multifarious and international, but she never lost her interest in savants, and her Accademia at Rome was thronged with poets, painters, authors, musicians, and scientists. Here she befriended and protected the uneasy-souled Borelli, whose name is often bracketed with that of Descartes, as a leader of the iatromathematical school which, as we have previously shown, reduced all physiology to physics, treating locomotion, respiration and digestion as mechanical processes, comparing every organ of the body to a machine—the teeth to a pair of shears, the chest to a bellows, the stomach to a flask, and so on. After a lifetime of stormy service for science, Borelli had been compelled to flee from Spanish persecution in Sicily, and the hunted man arrived in Rome, destitute—except for a priceless manuscript upon which he had been working for a generation. Christina immediately offered to publish it, and it is to her that *De Motu Animalium* is dedicated. Christina herself wrote continually, but her alleged *Secret Letters* and *Private Memoirs: Dedicated to God,* are forgeries.

A man of genuine piety never forgives a doubter simply because that doubter happens to be dead. Not satisfied with burning and torturing multitudes, Torquemada dug up the bodies of deceased heretics, and punished them in ecclesiastical style. As soon as Descartes was in his grave, the Jesuits redoubled their efforts against him, urging the Congregation of the Index to proscribe his works. Year after year their zeal was unavailing, but intolerance never dies, and on the twentieth of November, 1663, everything that Descartes had written was placed upon the Index Librorum Prohibitorum. This, of course, is where the books of Descartes belong, for here will be found nearly all the books which broke the fetters of the human mind. The Index Librorum Prohibitorum is an index of the books of progress. The inclusion of a book in this Index is usually sufficient evidence that it is a contribution to the spirit of science.

The cardinals who told Columbus that the world was not round, the cardinals who told Galileo that the world did not move, were succeeded by the cardinals who tried to keep the world flat and still by outlawing the brain that produced the *Discourse on Method.* But like the great explorer, Descartes sailed into unaccustomed seas and discovered new land, and like the great astronomer, he saw new stars shining on humanity's horizon. By clearing away the boulders of tradition, René Descartes opened up new paths in every realm of thought. He was one of the men who doubted, and thus saved the world.

(1628–1694)

MARCELLO MALPIGHI

After his studies of the liberal arts, Antonio Maria Valsalva was enrolled in the faculty of medicine and philosophy of the University of Bologna; and from the beginning of his studies he felt himself attracted to Malpighi, from whom he acquired that habit of positive observation and severe criticism which secured for him the highest esteem of his great teacher. In all the work of his life was shown his devout attachment to him who was his guide; and we are in the presence of the spectacle which, while not exceptional, is always fascinating, of a very distinct individuality, in which the animating breath of a teacher, who afterwards becomes a friend and companion in study, determines once for all the method of work and the system of the investigation, not the result of the latter. And as the old poets imagined that men truly great transmitted one to another the lighted torch of knowledge and truth, so we see transmitted this independent and profound spirit, this passionate love of truth, this fever of research, which knows no truce, from Malpighi to Valsalva, from Valsalva to Morgagni, from Morgagni to Antonio Scarpa, from Scarpa to Panizza.

ARTURO CASTIGLIONI.

IX

MARCELLO MALPIGHI

Upon the canvas of a century, history paints a series of pictures. And when we look at the seventeenth century, smeared across the foreground we see a picture in red—the Thirty Years' War. Charles v had attempted to bring the Lutherans back to Peter, but abdicated in disappointment, amusing his leisure by trying to make two watches work exactly alike. His failure caused him to remark indulgently, "I can't even compel two watches to agree, and yet expected to make two peoples think the same." Unfortunately his successor, Ferdinand of Styria, did not accept fate so philosophically; a pupil of the Jesuits, he undertook a pilgrimage to Loretto, and on the altar of the saints swore to exterminate Protestantism. Formerly the followers of Loyola had taught in lowly places—in the school-room and by the hearth—but now they stood behind a throne and instilled the poison of persecution in an emperor's brain.

Many bowed their heads to the new despotism, but in his native land the spirit of John Huss was not altogether dead; outraged beyond endurance, the Bohemians marched to the council chamber of Prague, seized two of the most notorious of their tormentors, and threw them out of a window—the ground being seventy feet below. "Help me, Virgin Mary!" cried Martinitz as he fell, and to the amazement of the spectators, the ejected stadtholders were not killed, and managed to crawl to safety. "A miracle wrought by the Virgin Mary!" exclaimed the Romanists, while the Hussites drily remarked that their escape was due to the lucky fact that they landed in a pile of manure.

But though the Thirty Years' War had its baptism in a dunghill, it drenched Europe in blood for decades. Catholic and Protestant called on Christ and drew the sword that was not to be sheathed for a generation. For a time Gustavus Adolphus, the noblest soldier of the age, appears on the scene, but the terrible Wallenstein, the Alva of the seventeenth century, pillaging city after city with his armed brigands, was the characteristic figure of this era. Thousands of populous villages became absolutely extinct; wolves roamed through the empty cottages, and in the air the ravens cawed dismally and died of starvation. Beneath the ruined corn-fields moldered the bones of mothers and babies. Peasants were hunted like rabbits, and nailed to posts as targets. Women were rounded up in herds and driven to camp to serve the soldiers. The people ceased to sow the earth, for the troops of Tilly reaped the harvest. Family life gone, property lost, the naked populace wandered through the country, feeding on dogs as hungry as themselves—and later human flesh was boiled in the fields and devoured. The long murder with its madness, pestilence walking with famine, typhus abroad with theology, made all Germany a yawning graveyard which swallowed millions.

Everything seemed to be reddened with a crimson mist. The dizzy brains of the people whirled in blood. On the earth not dew gleamed, but blood. In the ocean not water rolled, but blood. From the clouds not rain fell, but blood. From the eyes not tears dropped, but blood. From the breast not milk flowed, but blood. So the slaughter and the spilling continued for thirty years,—and often was heard the tolling of a chapel-bell, and the voice of a monk droning a mass to the glory of God.

When we turn from this huge religious panorama to contemplate the humbler vignettes of science, we see brighter pictures, for the seventeenth century was the century of Newton and Leibnitz, of Galileo and Kepler, of Halley and Flamsteed, of Gilbert and Wallis, of Descartes and von Guericke, of Napier and Briggs, of Romer and Huyghens, of Hooke and Drebbel, of Torricelli and Lippersheim—the golden age of astronomers and physicists, when for the first time the heavens really spoke to the earth. "In consequence of the innumerable new books," complained the industrious Leibnitz, "even the greatest literati cannot survey the whole field. Our scientific life has become a mere slop-shop."

In medicine, too, there was endless activity. At this period we meet Sydenham, the English Hippocrates; Willis, who differentiated between diabetes mellitus and diabetes insipidus; Felix Platter, who published the first classification of diseases; Glisson, who published a classic account of rickets; Thuillier, who showed that ergot was due to corn smut; Bontius, who described beriberi; Colle and Musitano, who showed that syphilis could be conveyed by kissing and from drinking-vessels; Guarinoni, who described gummata of the brain; Ramazzini, who opened up new medical territory—the immense field of trade-diseases.

The microscope now became scientifically available, and Leeuwenhoek bought hundreds of them, ground half a thousand lenses himself, and discovered the outposts of the invisible world of bacteriology, while Athanasius Kircher cast a suspicious eye on these recently-revealed microörganisms, already regarding them as the cause of infectious disease; Leeuwenhoek's pupil, the young Johann Hamm, first focused on the spermatozoa; Swammerdam viewed the red blood-corpuscles; Malpighi found the capillary anastomosis between arteries and veins; Robert Hooke saw and drew the plant-cells; and Clopton Havers described the microscopy of bone.

Obstetrics emancipated itself from the midwives, and was molded into a science by the hands of such men as Mauriceau, Deventer, Paul Portal, de la Motte, and van Hoorn. The obstetric forceps was invented at this time by the Chamberlens, but it is not with pride that the historian records it, for this useful instrument was kept a secret in the family for generations. Nature frequently puts talents into the wrong hands.

Chemistry was advanced by the labors of van Helmont, who introduced the term and concept of "gas"; by Lemery, who demonstrated the presence of iron in the blood, and whose *Cours de Chemie* was a valuable compendium of the chemical knowledge of the time; by Sylvius (de la Boë) who proved the presence of volatile alkalis in plants, and trained several eminent pupils; by Boyle, who enunciated the law of pressure upon gases which is still known as Boyle's Law, and who applied Francis Bacon's inductive method to chemical problems; by Mayow, who was on the trail of oxygen and the true theory of respiration; by Kunckel, who regarded chemistry as the basis of medicine. Unfortunately, the chemistry of this period was marred by the birth of Becher and Stahl's phlogistic doctrines. George Ernst Stahl was the type of the propagandist who has done so much damage to truth: he was learned, honorable, and wrong. He regarded his opinions as a revelation from God, and by his constant insistence on them he held chemistry captive to a false theory for over a century. He was one of the men who turn the stream of progress backward—his views on combustion were far behind those of his predecessor, John Mayow. If nature had given Stahl's mother a contracted pelvis, science would have been the gainer.

Although all the excreta of all the animals retained their honored places in the pharmacopeias of the period, the materia medica was enlarged by the introduction of numerous remedies which have a more modern sound: benzoic acid was described by Blaise de Vigenere, sulphate of potash by Oswald Croll, tartar emetic by De Mynsicht, calomel by Beguin and de Mayerne, ipecac by Piso and Helvetius, black cohosh by Plukenet, cowhage by Parkinson, pareira brava by Pomet, calumba by Redi, star-anise, vanilla, and gamboge by Clusius, tartrate of potassium by Lemery, Iceland moss by Borrich and Hjarne, cascarilla by Stisser, serpentaria by Thomas Johnson, petroleum by De La Roche d'Allion, acetate of mercury by Lefebure; cinchona, catechu, jalap and lycopodium were introduced into Europe; Nehemiah Grew discovered magnesium sulphate in Epsom waters, Glauber discovered sodium sulphate and zinc acetate, Padre Acugna discovered oil of copaiba, Brandt discovered phosphorus, and Sala discovered the method of preparing silver nitrate.

Work of enduring value was done in otology and ophthalmology, especially by Duverney, Maitre-Jean, Brisseau, and J. J. Rau. Gastrotomy, resection of the jaw, amputation of the thigh, transfusion, and intravenous medication were among the surgical procedures introduced at this time; Sanctorius' trocar, speculum and lithotrite were among the instruments invented; and Hildanus, Hytell, Dionis, Purmann, Muralt, van Solingen, Wiseman, Magati, Marchetti, Severino, Musitano, Scultetus, were among the prominent surgeons—names of importance, though hardly epoch-making.

But if seventeenth century surgery did not advance further than Paré, workers in anatomy and physiology poured far beyond the broad gate that the scalpel of Vesalius had opened: half the structures in the human body are named after seventeenth century men—Graafian follicles, Haversian canals, Glasserian fissure, Pacchionian bodies, Bellini's tubes, antrum of Highmore, Malpighian layer, circle of Willis, valves of Kerkring, Schneiderian membrane, Glisson's capsule, Casserio's artery, Peyer's patches, Lower's tubercle, Pecquet's cistern, Poupart's ligament, Wormian bones, Ruysch's tunica, Spigelian lobe, Ridley's sinus, Riolan's muscle, Tulpius' valve, Vieussens' ganglion, Nuck's canal, Wirsung's duct, Wharton's duct, Stensen's duct, Rivini's duct, Bartholin's glands, Brunner's glands, Cowper's glands, Meibomian glands.

To this period belongs the "triple discovery" of the lymphatics, the lacteals, and the thoracic duct, and it followed the chief physiological discovery of all time—Harvey's demonstration of the circulation of the blood. Harvey's book on the subject was published in 1628—not in London, however, but in Frankfort-on-the-Main, as the British censor, with the characteristic intelligence of censors, refused to permit its publication at home, though to-day England considers the author of *De Motu Cordis* its medical Shakespeare.

In the very year that this book appeared, a swarthy-skinned child lay in its cradle, but as he was destined to carry on Harvey's work, we must follow him with interest—from the time that he toddled aimlessly around his parents' house, until his first steps in the larger world outside, until he walked with glory in new-found paths of science, striding through many avenues of research, even until that later time, when like a tired wanderer, he slowly tottered down the last road of life.

Marcello Malpighi was born on the tenth of March, 1628, at Crevalcuore, a town so small it is doubtful if it had a town harlot, but it has its place on the scientific map. In 1630 a shock of terror ran through Italy—the plague. Not only did it desolate Milan, Florence and Mantua, but it was raging in Bologna—and Bologna was less than twenty miles from Crevalcuore. And when the plague came, death wore league-boots—twenty miles was as nothing. Any moment it might be necessary to send for the pest-doctor, and when he approached in his long red robe of Cordova, inhaling the fumigants that filled the huge leather snout that covered his nose, peering cautiously through his stout mask, it was time, too, to send for the priest.

As if God's wrath were not enough, men must add their evil deeds: on the first of June, while the plague was sweeping through Milan, a woman looked out of her window and saw a man smear the houses with plague-salve. It was health commissioner Piazza, and when accused of spreading the pestilence he protested that he had been writing from an ink-horn at his belt, and was merely wiping his ink-stained fingers against the wall. But after enduring the torture twice, he confessed his crime, and stated that the barber Mora had given him the poisonous ointment—and one ordeal made the barber also admit his guilt. Later they recanted, swearing it was the torture that made them yield, but what man in all Milan believed them innocent? The bodies of Piazza and Mora were torn with red-hot pincers, their hands were cut off, their bones were broken, for hours they were stretched on the wheel, then they were burned and their ashes scattered into the river. The house of the crime was razed to the ground, and on the spot was erected a Column of

Infamy, describing the trial and ending with the warning, "Keep afar off, then, afar off, good citizens, lest this accursed ground should pollute you, with its infamy."

Who knew if such a column might not replace the olive-trees of Crevalcuore? Next to the Malpighis lived the Sbaraglias, a sinister clan who would not scruple to use the plague-salve. But disquieting thoughts like these did not disturb happy little Marcello Malpighi. He had long graduated from the cradle, for he was now two years of age and could do many things: he could laugh in Italian, and could chase the chickens over his father's farm, and could say *grazia* for a piece of orange—but sometimes wouldn't.

Youth that is passed at home is seldom eventful—especially if father's income is sufficient—and Malpighi remained with his parents until his seventeenth year, beloved for his affectionate disposition and intelligence. In 1645 he left Crevalcuore to pursue philosophy at the University of Bologna. Here he studied uninterruptedly until 1649, by which time he was twenty-one years of age, but then fate gave him his first blow, and it was a smashing triple blow—almost at the same time his father, his mother and his grandmother, died. Plato and Aristotle served very well in the days of tranquillity, but how futile their philosophy seemed to a heart raw with sorrow. The lad was prostrated, yet in the midst of his affliction heard the stern voice of duty. He was the oldest of a family of eight, and the three children next to him were girls. Let the sobs choke him and the tears blind him—he had work to do. The old folks must be buried, his younger brothers and sisters must be comforted, the estates needed attention: easeful boyhood was over, and manhood with its responsibilities had begun.

Money and horses and silver spoons are not the only possessions that parents hand down to their children; often they bequeath heirlooms which are not mentioned in their wills, and which no smart lawyer can set aside; Malpighi, for example, inherited a feud. Of course some men would have been delighted with a feud; they could have enjoyed themselves with it, but

Marcello Malpighi was a scholar, not a fighter, and although from the adjoining property the Sbaraglias scowled at him, he thought of his books and not his dagger, and the next year he was at the University again. We may mention, however, that Malpighi's younger brother, Bartolommo, had some Benvenuto Cellini stuff in him, and some time later so far forgot himself as to kill one of the Sbaraglias.

Back at Bologna, Malpighi enrolled as a pupil under the peripatetic philosopher, Natali, who gave him at least one valuable lesson: "Study medicine," he advised him. So in 1651 Malpighi became a pupil of Massari, Professor of Medicine.

It was now many years since Vesalius and Fallopius had exposed the mistakes of Galenism, but a university is sometimes the last refuge of ancient error, and several of the professors at the University of Bologna still clung to the old doctrines, but Bartolommeo Massari was the radical of the faculty: not only did he expound the new learning, but like a true Vesalian he dissected human bodies in his own home.

Among the favorite pupils who were admitted into this circle was young Malpighi, and the discussions, the dissections, and the experiments, stirred his mind mightily. The pursuit of knowledge by the experimental method was still novel, and what its devotees lacked in numbers they made up in fervency. It is difficult to be ardent about something that everyone believes in—it is taken as a matter of course. Real enthusiasm is the privilege of the minority.

Yet Malpighi's attention was not exclusively occupied by the new learning, for there was a Miss Francesca Massari in the house, and it is odd how frequently pupils have fallen in love with the female relatives of their masters. In 1653 Malpighi graduated in medicine and philosophy, his thesis being a defense of the Hippocratic method of unprejudiced observation as opposed to the dogmatism of Galen. Now that he was a doctor he could get married, and in 1654 Francesca became his wife.

But sorrow does not walk far from joy: the next year the Malpighis were mourning the sudden death of Massari. Fortunately, a new interest came into Malpighi's life, for in 1656 the Bolognese senate nominated him as public lecturer in medicine, and he had no sooner undertaken his duties than Ferdinand, grand duke of Tuscany, created for him the chair of Theoretical Medicine at the University of Pisa.

The enmity of the Sbaraglias was a nuisance to Malpighi, there is always a lure in a strange place, and the University of Pisa was famous—it was one of the hobbies of the Medici family. So the twenty-eight year old professor journeyed to Pisa near the sea. It is said that during one of his first lectures the new doctrines which he expounded so offended the members of his audience, that they gradually withdrew until only one listener remained.

If this story is true, it was no misfortune for Malpighi, for that one man was Giovanni Alfonso Borelli, formerly of Naples. Borelli was the medico-mathematician who viewed the human organism as a machine, treating muscular motion, respiration and digestion as mechanical processes, explaining physiological problems by the laws of physics. An irascible man, of a morose and quarrelsome disposition, assertive, aggressive, antagonistic, usually unpleasant and often unbearable, Borelli was nevertheless a profound thinker who not only did important scientific work himself, but inspired others to achieve and accomplish. It was under Borelli's direction that Auber discovered the structure of the testicle, and Bellini, a youth of nineteen, discovered the uriniferous tubules, and it was while working with Borelli that Malpighi made his first discovery—the spiral nature of the fibers of the bullock's heart. Borelli was twenty years older than Malpighi, and the younger man looked upon him as a father, consulting him almost every day. Borelli taught Malpighi the physics of Galileo, and Malpighi instructed Borelli in biology. The relationship between them indicates how modest and lovable Malpighi must have been, for few could get along with the fierce Neapolitan. Together they performed dissections which were attended by dukes and princes, thus giving rise to the Academy of Experiment, which was soon removed to Florence, the Academicians meeting in the Ducal Palace, where the royal host and his family mingled freely with them.

Galileo was a Pisan, but Malpighi was not even Pisa-plated; he claimed the humid climate did not agree with him, for although brought up in the country he was always in delicate health, and after three years he returned home, meeting and studying with Fracassati and Buonfigluoli, life-long friends.

The riddle of respiration had puzzled philosophers at least since the days of Aristotle, and surely it is interesting to know how we breathe. Many of the acute minds of the mid-seventeenth century—Boyle, Hooke, Lower, Mayow, and Borelli—tackled this problem, and in 1660 it became the object of Malpighi's inquiry. Up to this time the lung had been regarded as a sort of porous parenchyma—Fabricius compared it to tow—and it was believed that somewhere within its substance the smaller divisions of the pulmonary artery lost themselves, pouring out their blood into the open spaces, where it was later gathered up by the pulmonary veins, while the minuter parts of the windpipe were also supposed to terminate in this fleshy tissue. But now, with the aid of his lenses and the lungs of a dog, a tortoise, and a frog, Malpighi began that series of observations which have caused him to be regarded as the greatest of microscopists and the founder of histology.

He showed that instead of a perforated mass in which the blood was poured and then sucked out, the lung was vesicular in nature, the bronchi being continuous with the air vesicles, the air and blood of the lung never actually in contact, but separated by a membrane, and that the blood was constantly within channels, even when crossing from the arteries to the veins—for he observed the capillary circulation. This momentous discovery bridged the one remaining gap in the Harveian hypothesis—for Harvey could never explain where or how the interchange occurred between arterial and venous blood. Malpighi wrote:

I saw the blood, showered down in tiny streams through the arteries, after the fashion of a flood, and I might have believed that the blood itself escaped into an empty space and was gathered up again by a gaping vessel, but an objection to this view was afforded by the movement of the blood being tortuous and scattered in different directions and by its being united again in a determinate part. My doubt was changed to a certainty by the dried lung of a frog which to a marked extent had preserved the redness of the blood in very minute tracts, which were afterwards found to be vessels, where by the help of a glass I saw not scattered points but vessels joined together in a ring-like fashion. And such is the wandering about of these vessels as they proceed on this side from the vein and on the other from the artery that the vessels no longer maintain a straight direction, but there appears a network made up of the continuations of the two vessels. This network not only occupies the whole area but extends to the walls, and is attached to the outgoing vessel, as I could more abundantly and yet with greater difficulty see in the oblong lung of the tortoise, which is equally membranous and transparent. Hence it was clear to the senses that the blood flowed along sinuous vessels and was not poured into spaces, but was always contained within tubules, and that its dispersion is due to the multiple winding of the vessels. . . . From the simplicity which Nature uses in all her works, it may be concluded from these results that the network which I once thought to be nervous in character is really a vessel attached to the vesicles and sinuses carrying thither the mass of the blood or carrying the same away, and that although in the lungs of the more perfect animals a vessel seems sometimes to leave off and gape in the middle of the network of rings, yet it is probable that, as in the frog and the tortoise, the vessel in question is prolonged further into very small vessels after the form of a network, although these on account of their exquisite fineness escape our senses.

These discoveries were announced in two epistles which Malpighi dedicated and sent to Borelli, who was very much pleased with them, and urged that they be published. Thus, in 1661, *De pulmonibus observationes anatomicæ* appeared from the press, laying the anatomical foundation for a true conception of the respiratory act.

In the following year, scientific circles learnt that the chair of medicine at Messina had become vacant through the death of Pietro Castelli; before coming to Pisa, Borelli had taught in the Sicilian university, and he immediately wrote to its senate, recommending the appointment of Malpighi. And when Malpighi was invited, he agreed to go—even the fact that he was offered a good salary did not frighten him, for he could accept it in his wife's name.

In a temperate region, nature is garbed as a respectable matron, but in Messina she is arrayed as a wanton, in many colors and odors—the spectrum suffused in perfume; languorous and passionate, she is warmed by the sun of Sicily and bathed by the waters of the Mediterranean; with her extravagant and uncurbed beauty, in each generation she allures afresh the tribe of Theocritus. But Malpighi did not watch the tints of azure blend with the smell of myrtle; this poet's paradise was to him a workshop; he took out his tools and began his labors.

The sea at his feet teemed with life; in the shark he found the spiral intestinal valve, and in the sword-fish saw the twisted optic stalk. Of course he wrote about his researches to Borelli, who answered, "I was astounded by the drawings of the optic nerve of the swordfish, of which observations you should make great capital, and should easily find traces of this in other larger animals, such as the ox. If it proves to be so I should advise you to compose a treatise upon the subject and have it published."

The years at Messina were fruitful ones; Malpighi was in his early prime, and activity was a joy and a necessity. He thought of writing a great work on anatomy, reviewing the whole subject, and in accordance with this plan he completed a chapter on the circulation and on the lungs, but when Borelli and Fracassati heard of it, they objected loudly, telling him that such a task was for second-rate men, and that a Malpighi must not become a compiler; Malpighi's Sicilian patron, the enlightened Viscount Ruffi, joined in the protest, and Malpighi agreed to devote himself to original work exclusively.

He studied the brain, discerning the cortical cells and their connection with nerve fibers, and showing that the fibers of the white matter form tracts which connect the surface of the brain with various regions of the spinal cord.

The papillæ of the tongue were believed to be secretory in nature, but Malpighi merely stuck his tongue out, which soon became dry, and thus again an unpretentious fact overthrew an elaborate theory. Malpighi was able to demonstrate their provision of nerve filaments, and from this he deduced their gustatory function.

He studied hair and feathers and skin; he discovered the papillæ in the skin, and as they were most abundant where the sense of touch was most developed, he correctly announced that he had discovered the organ of touch. He further discovered the lower layer of the epidermis, the rete mucosum, since known as the Malpighian layer, and he pointed out that here accumulates the pigment that makes the negro black. The pigment in the white man's skin is the same as in the black man's skin, only the latter has more of it, but this simple anatomical fact has made the black man an outcast on the white man's earth.

While investigating fat, he made microscopic examinations of the mesenteric blood-vessels of the hedgehog, and in recording one of his observations, wrote,"And I myself in the omentum of the hedgehog in a blood-vessel which ran from one collection of fat to another opposite to it, saw globules of fat, of a definite outline, reddish in color. They presented a likeness to a chaplet of red coral." But like Columbus who discovered a new continent and knew it not, it was more than globules of fat that Malpighi saw—it was the red blood corpuscles; and his simple words were the first published record of the minute structures which have since been studied in infinite detail in every physiological laboratory.

In 1665—the year that the Royal Society of London published the first volume of its *Philosophical Transactions,* and

Newton announced the law of gravitation—Malpighi printed the essay embodying his observations of the erythrocytes—*De omento, pinguedine, et adiposis ductibus;* at the same time, he published three other tracts, in which were recorded the discoveries that have been named above. *De cerebro exercitatio epistolica* was addressed to Fracassati, *De lingua exercitatio epistolica* to Borelli, and *De externo tactus organo exercitatio anatomica* was dedicated to Ruffi.

But Malpighi had already completed a more important manuscript, *De viscerum structura exercitatio anatomica,* containing his work on the glands: the liver, the spleen, and the kidneys.

Malpighi apologised for writing on the liver after Glisson had already written so well, but Malpighi for the first time showed the liver to be constructed after the fashion of a conglomerate secreting gland, composed of hexagonal lobules, and decided that the bile duct was the ordinary secretory outlet of the liver, and proved by an experiment upon a kitten that bile is secreted by the liver and not by the gall-bladder.

This was good work, but Malpighi began the essay in diffidence and ended it in humbleness:

> Among various questions which arise out of the discoveries which have been described, two stand out prominent. By what mechanism is the bile separated in the glandular acini of the liver, and what is the use of the bile in the economy? The illustrious Pecquet has made many deductions from the principles of mechanics concerning the former; since, however, acinus is so minute that it cannot be laid bare by even the very best microscope, we can only have recourse to hypotheses and to the working of similar mechanisms in attempting to explain this. As to the use of the bile, it is probable that after the food has been triturated in the stomach, juices of a different nature are poured upon it from the glands of the liver and of the pancreas, for a purpose not unlike that which appears in the cooking of food when out of sweet, sour and salt things mixed together, a new composition and a new taste are developed. Let the wide industry of others carry matters further; I am contented to have described the simple and rude structure of the liver.

How well he studied the kidney is apparent from the fact that to-day a glomerulus of the kidney is known as Malpighi's tuft, that the conic masses in the medullary portions of the kidney are known as Malpighi's pyramids, and that the rounded terminal dilatations of the convoluted uriniferous tubules are known as Malpighi's bodies.

He wrote his name also on the spleen, that mysterious organ which still has secrets that no physiologist knows. Malpighi described its vessels, parenchyma, trabeculæ, and capsule. "I found," he says, "the glands or vesicles distributed through the whole spleen like bunches of grapes. These have an oval form and are not much larger than the glands of the kidneys. They are, as I always observed, white, and even if the vessels are made turgid with a black injection they preserve their color. They are soft and friable and one can see no cavity in them." The masses of adenoid tissue in the splenic pulp are Malpighi's corpuscles, and the orifices of the capillaries that join the branches of the splenic vein, are Malpighi's stigmata.

When we reflect that all these discoveries were made within four years, and that during this quadrennium much of his time was devoted to teaching at the University, we realize how gifted and successful a worker was Marcello Malpighi. But in the midst of his occupations he found time to remember that Messina was not his home. He wrote:

> The fourth year of my stay slipping by, and the curriculum of lectures being completed, I meditated a return to my own country. But it pleased the illustrious senate of Messina to request, in April 1666, that I should continue yet another four years and with this in view I started to Bologna in the beginning of May with the plan, and if my health and domestic affairs permitted, of returning in the autumn. In Naples I met the learned Cornelius and Leonardus and others of that school and talked and consulted with them as long as I was able, to the great recreation of my mind. In Rome it was my fortune to meet for the first time the famous Stensen, who was very suave and friendly. At length I reached Bologna

safely. After a short bodily rest I had printed the material which I had arranged concerning the structure of the viscera.

At Bologna he met his old friends, Fracassati and Buonfigluoli, who were overjoyed to see him. Malpighi was soon busy again, practicing medicine, performing autopsies, lecturing, investigating. Before he knew it, autumn had come, and he received a note from the senate urging him to hasten back, but he made up his mind to remain in Bologna. Messina accepted his resignation with unwillingness, but cordially wished him happiness and success.

In the writings of Malpighi we find many generous references to his fellow scientists: "as the most learned Fallopius has very well observed . . ." "as Glisson, in that work of his on the liver which cannot be too highly praised, has very clearly shown . . ." "the famous Stensen . . ." "the illustrious Pecquet . . ." "the most learned Borelli . . ." Personally, Malpighi was just as friendly and charming, and now that his wanderings were over, he sought the companionship and correspondence of savants the world over. He was in communication with Sylvius (de la Boë) of Leyden; with Thomas Willis, of London, whose cerebral studies were more significant than Malpighi's; with Bartholin, the Dane; with Meibom, of Lubeck, who discovered the glands in the eyelids which bear his name; with Lorenzo Bellini, of Florence; with Redi, of Arezzo, the physician-poet who proved the untenability of the theory of spontaneous generation; with Abraham Vilna; with Joachim Elsner; and with various others.

Sometimes he had distinguished guests, as when Nicolaus Stensen, whom he had met at Rome, visited him at Bologna. Stensen, who was ten years younger than Malpighi, was born at Copenhagen; at the age of eighteen he became a pupil of Thomas Bartholin, a famous member of a famous family. Two years later the Swedes besieged the Danish capital, and Stensen was one of the students who defended the city. He was faithful in building ramparts and fighting the invaders, and during the intermission, in order not to waste time, he attended lectures at the university. After graduation, we find him at Amsterdam, studying under Blasius. One morning, while dissecting the head of a sheep to examine the parotid gland, the point of his knife slipped down an opening and struck with a sharp click against the teeth, and the fortunate youth knew he had discovered the duct which has since been known as Stensen's duct. This observation was embodied in his *Observationes Anatomicæ,* published at Leyden, in 1662, in the twenty-fourth year of his age.

It may be mentioned that Blasius attempted to gain credit for this discovery, probably because it had been made under his roof, and he had the effrontery to present his claims to Bartholin, who answered him, "Farewell, and control yourself." To Stensen, Bartholin wrote a letter which was less epigrammatic and more hearty:

> Your assiduity in investigating the secrets of the human body, as well as your fortunate discoveries, are highly praised by the learned of our country. The fatherland congratulates itself upon such a citizen, I upon such a pupil, through whose efforts anatomy makes daily progress and our lymphatic vessels are traced out more and more. You divide honors with Wharton, since you have added to his internal duct an external one, and have thereby discovered the sources of saliva concerning which many have hitherto dreamed much, but which no one has (permit the expression) pointed out with the finger. Continue, my Steno, to follow the path to immortal glory which true anatomy holds out to you.

When Stensen read this letter from his teacher, no doubt he vowed to follow the paths of science all his life; alas! it is easier to battle against the Swedes than to fight Fate. It is true that Stensen's first discovery led him to speculate brilliantly on secretory glands, and he added to his renown by his cerebral studies, and by proving that the heart is a muscle; later he wrote a book which won for him equal fame in an entirely different science—geology; he was an accomplished linguist, speaking French, German, English, Italian, Dutch, Latin, Greek, Hebrew,—but many languages could not save him.

Destiny waited for that fine brain, and at last beclouded it. Stensen, whose father was court jeweler at Copenhagen, had been brought up as a strict Lutheran, and it is said that at Paris when the distinguished Bossuet tried to make a Catholic of him, Stensen scornfully informed him that he had no time for such things. But Fate has time. In Italy, a chance conversation with an obscure monk—a nun, according to others—achieved what Bossuet had failed to accomplish: Stensen became a Catholic. Such a convert was received most willingly by the Church; he was appointed Bishop of Titiopolis in Greece, and as Vicar Apostolic to the northern nations, he traveled from place to place on a tour of proselytism. The nerves of the heart had never been satisfactorily delineated; many thought that the coagulation of blood was due to its cooling, but was this really the case? Glisson claimed that irritability was a specific property of all organized tissue, but no one had proved it. Here were problems for the sagacious Stensen, but they no longer tempted him. Clad in bishop's robes, he walked other paths, sorrowing for the souls of heretics. The apostle of physiology became its apostate.

But neither Malpighi nor Stensen knew what the future had in store for the great Dane, and that day at Bologna they talked eagerly of many earthly subjects; among other things they discussed vision, but to Malpighi's regret, it was only after his guest had departed, that he saw in the eye of a screech-owl which he had opened laterally the inverted image on the retina —"trees, the house, all inverted, and whatever was on the right now came on the left."

In 1667 Malpighi received a letter which had been addressed to him at Messina, but had arrived after he left Sicily, and was forwarded to Bologna. It was from Henry Oldenburg, the Admirable Crichton of the Royal Society of London, whose versatility and urbanity, however, could not overcome his Bremenish name, and when it was discovered that he was corresponding with forty foreigners, Lord Arlington wrote a little note: "Warrant to seize the person of Henry Oldenburg for dangerous designs and practices, and to convey him to the Tower." But within a few months the government seemed convinced that Oldenburg's correspondence with men like Spinoza, Leeuwenhoek, Stensen, Swammerdam, and Malpighi, contained nothing especially dangerous, and he was released, and the Royal Society resumed its meetings. Oldenburg, in his letter to Malpighi, expressed the Royal Society's appreciation of his worth, and invited him to correspond with them on plants, minerals, and insects—especially the silkworm.

The origin of the Royal Society of London, like the origin of almost everything else, is involved in obscurity, but it is an historic fact that it was chartered in 1662 by Charles the Second—the solitary good act of the sovereign who made adultery a duty, and sold his country to Louis XIV and his soul to perfidy.

Who shall account for the remarkable growth of science in England at this time? What connection is there between a nation's political position and its scientific achievements? The student of the seventeenth century will be puzzled for an answer. Germany was despoiled by the Thirty Years' War and fell behind in culture, while Holland, which had thrown off the ever-accursed yoke of Spain, could point to many glorious discoveries; but on the other hand, Italy was only a "geographical expression"—the property of Bourbon and Hapsburg, two families that have brought much misery to the human race—and yet at this time Italy produced several of her greatest men of science; while France, which was at the height of its commercial and military power, brought forth that barren medicine which deserved and excited the satire of Molière. Learning is believed to flourish best in the gardens of quietude, but the country that decapitated its king and established the great Commonwealth, only to be later ravished by the Restoration, to say nothing of the Great Plague and the Great Fire, will not be accused of enjoying calmness. Possibly the reëstablishment of political tyranny by the son of Charles the First, made men's minds seek an outlet in other directions, but whatever the explanation may be, the fact remains that science became epidemic in London.

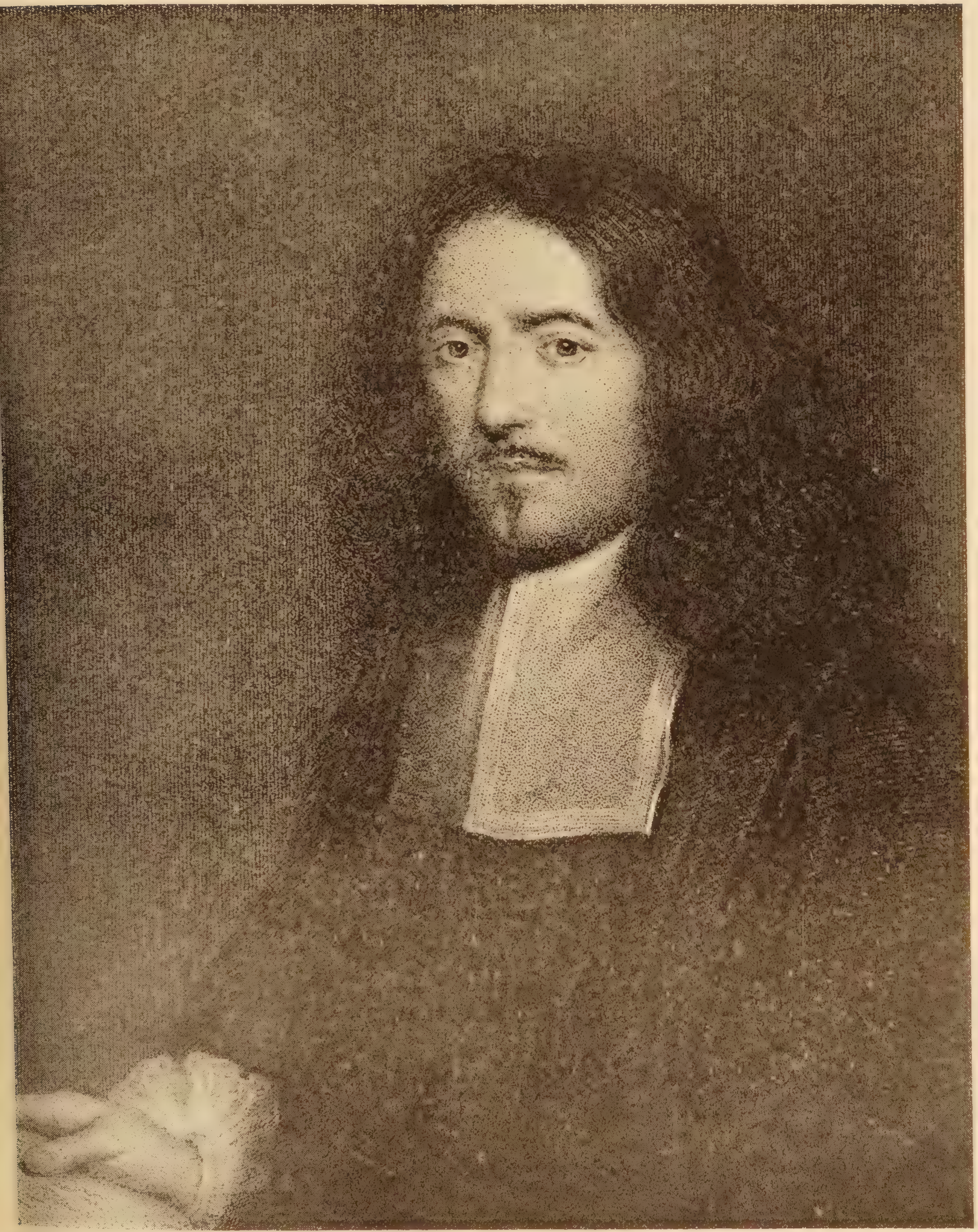
The poet Cowley wrote an Ode to the Royal Society, and Dryden apostrophized it, declaring it would soon enable us to converse with our celestial neighbors:

> Then we upon the globe's last verge shall go,
> And view the ocean leaning on the sky;
> From thence our rolling neighbors we shall know
> And on the lunar world securely pry.

Thomas Hobbes became a court favorite. To show the taste of the times it may be mentioned that John Locke, the philosopher-physician, received for the *Conduct Concerning the Human Understanding,* which is hardly more than a pamphlet, thrice the amount that Milton received for *Paradise Lost,* a poem of over 10,000 lines.

The Duke of Buckingham worshiped the trinity of wine, woman, and chemistry. The valiant Prince Rupert dropped molten glass into cold water, thereby inventing the brittle curiosity that has since been known as Prince Rupert's Drops. The Duchess of Newcastle came to one of the Society's meetings, and for her benefit the Fellows weighed a large receiver from which the air had been exhausted, and after placing it on a scale the air was allowed to enter—and the container weighed more; then they took two cool liquids and mixed them together, and to the delight of Her Grace, the fluid became hot.

Charles the Second fitted up a laboratory at Whitehall, and performed amateurish experiments with mercury and phosphorus. In Pepys' *Diary* we find this: "Charles the Second saw Dr. Clarke and Mr. Pierce dissect two bodies, a man and a woman, with which his majesty was highly pleased." But although the Merry Monarch styled himself the Founder and Patron of the Royal Society, he never once visited its meeting-rooms, and at times when its finances were so low that it was about to disband, he offered no pecuniary aid, but spent much money on the caprices of his mistresses. During the last ten or fifteen years of his reign he did not seem to be aware that the



MALPIGHI

W. Faithorne del. et sculp
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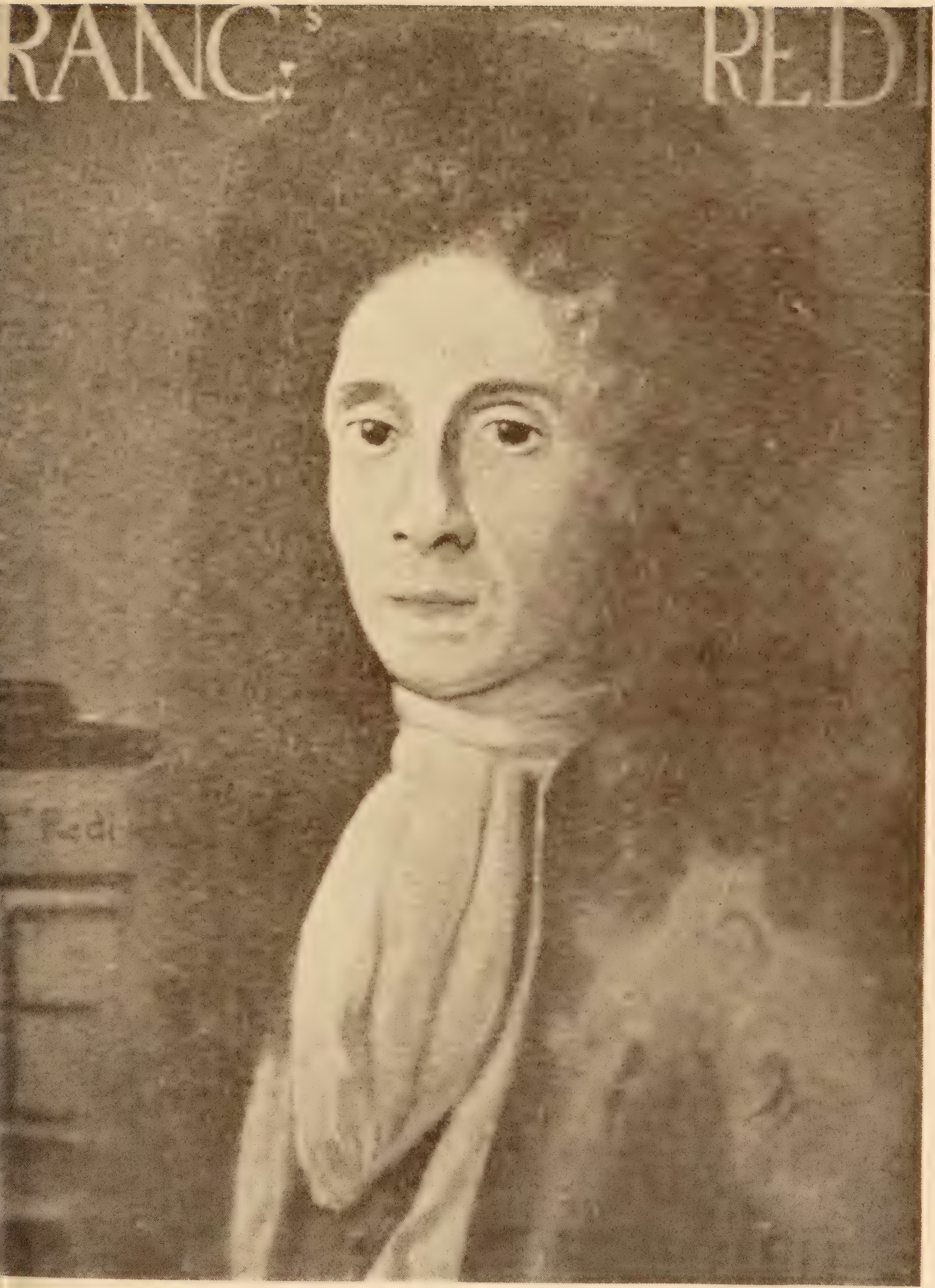
Ætat. Suæ 80

FRANCIS GLISSON

Courtesy of the Royal College of Physicians of London.

THOMAS WHARTON

Courtesy of the Royal College of Physicians of London.



FRANCESCO REDI

Society existed, and held no communication with it whatsoever. That the Society resented this attitude of indifference need occasion no surprise: when the king died, the Royal Society did not adjourn, and no record of his decease is to be found in the minutes. Nature never intended a Stuart to be anything except indecent.

To the courtiers, an experiment was a fad; to the real members of the Society, it was a passion. A more wide-awake group of men never gathered together. Whenever they heard of a new book, they read it; whenever they heard of a new experiment, they repeated it. They discussed their observations of Saturn and the history of wax-candles; they were interested in a new star and in the development of clothing; they inquired about Africa and about the man who lived without a spleen; they investigated earthquakes and a double goose-egg; they asked about a key to the Chinese language and whether the venereal disease existed in Numidia; they studied magnetism and the heart of an eel; they paid attention to the ebb and flow of the sea and to the corroding effects of cider on a knife; they were attracted by a new classification of birds and by an individual who could remain three hours under water. Their activity in every -ology was feverish, and although some of their experiments, as reviving drowned animals, and transfusing blood from dog to dog, and from sheep to man, produced more wonder than results, both by the universality of their sympathies and by the splendor of their discoveries, the Royal Society of London became the foremost of scientific associations.

Malpighi, of course, had often heard of the Royal Society, and was glad to comply with their request: in 1668 he began to cultivate and study the silkworm. He hatched them, watching them day by day, dissecting them at various stages. He described their external form, musculature, tracheæ, nerves, heart, intestines, their habits, generative organs, egg-laying and silk-spinning apparatus—and he drew pictures of all that he saw. To prove the respiratory nature of the tracheæ, he clogged up these organs with a drop of oil or honey, and the animal died in convulsions—while a monk might say a paternoster. He compared the silkworm with the locust, the pine-caterpillar and the firefly.

By the time he got through there was only one man who knew more about little creatures than Malpighi, and that was Jan Swammerdam, who corrected some of his mistakes. Ah, here was a character! After Jan Swammerdam graduated in medicine, his father insisted that he practice, but the boy was too much of a scientist for that. They quarreled, but it was the father who yielded. Jan Swammerdam never killed or cured a patient. But he observed the red blood corpuscles before Malpighi, although his observation was not published until many years later; he discovered the valves of the lymphatics, and was the first to announce that a lung which has once drawn the breath of life will not sink in water; also, he described 3,000 species of insects. When Swammerdam drew the finer anatomy of a mayfly or a bee or a worm, it was a work of art in miniature, and its richness of detail and delicacy of craftsmanship made the drawings of others look like rude sketches. His patience had no limit; in summer he began his task at dawn, and worked in the open as long as he could see; in order not to interrupt the light he wore no hat, and paid no attention to the sweat that streamed down his face.

But there came an evil day for science and for Swammerdam—he read the books of Antoinette Bourignon. One would suppose that a noble intellect would turn in contempt from their irrational rant—frenzied statements unsupported by evidence, and logic that would have shamed naked aborigines. But the mind of Swammerdam succumbed to the mystic jargon; the woman convinced him of the sinfulness of science: he joined her fanatical sect, and for the remainder of his life repeated its delirious babble. The hand that had been so cunning, no longer injected wax in the vessels of the queen bee; the works that he had written he did not publish, nor did they see print until he had long been dead; the long brass table, which Samuel Musschenbroek had made especially for him, and which had been so crowded with specimens for study and dissection, now stood empty and idle; upon it lay his scalpel unused—growing dull, like the brain of its owner. Jan Swammerdam, like another Stensen, became a lost leader of physiology.

Concerning his own work on the silkworm, Malpighi has an interesting note:

> I tried to show not only the external mutations but the relations and structure of the viscera. This was a most tedious and laborious task, and fatigued by months of toil I was seized with a fever and an inflammation of my eyes in the autumn. Still, notwithstanding these difficulties, there was a mental delight in this work—in finding so many and puzzling miracles of nature that I cannot describe them with my pen. My collected observations, with drawings, I sent in the beginning of the year 1669 to the Royal Society.

The Society was certainly gratified that such a work should be dedicated to them, and when Oldenburg proposed that Signor Malpighi be made a member, he was elected *nemine contradicente,* and Secretary Oldenburg had the pleasant duty of sending to his Italian friend a diploma in Latin, which being translated into English, reads:

> Master Marcello Malpighi, most renowned for his knowledge of medicine and anatomy, physician and professor of Bologna, and professor in the University of Messina, has shown most clearly his great regard for this Society and for the advancement of true philosophy, by his most excellent and learned contributions. Therefor, on March 4th, in regular session, this Society unanimously elected the distinguished Malpighi a member, and as evidence we herewith set our seal upon this public record. Given, London, 1669, in the reign of Charles II, King of Great Britain, France and Ireland, and founder and patron of the Society.

This was on the fourth of March, 1669, and on the twenty-first of October the Society received Malpighi's acknowledgments in a letter dated the fifteenth of July, for in those days Bologna was a long way from London.

The Society delegated Robert Hooke to peruse and report on Malpighi's discourse on the silkworm, and at the next meeting Hooke declared that he found it very curious and elaborate, and well worth printing, and accordingly the presses of the Royal Society turned out *Dissertatio Epistolica de Bombyce.*

When we mention the name of Hooke, we utter one of the most amazing names in all the annals of science. As a child he was too frail to study for his father's profession—a parish minister. Later he was employed by the wealthy Robert Boyle, the foremost chemist of the age. After the great fire destroyed London, Hooke submitted a plan for the reconstruction of the city, and although the model of Sir Christopher Wren was finally adopted, Hooke's idea was much admired, and when a new London was rising out of the ashes, Hooke's services were constantly in demand as a surveyor and builder, an occupation which netted him quite a fortune.

Hooke was early appointed curator of the Royal Society, his duty being to perform experiments, and so inexhaustible were his intellectual resources, that for several years he announced new discoveries at almost every meeting. To whatever path of science we turn, in the vanguard we will find the footsteps of Robert Hooke. He was the greatest of the English microscopists, and his *Micrographia,* published in 1665, contained the first description and drawings of the biologic cell. He was the only man of his century who knew the art of auscultation—he listened to the voice of the heart and lungs. He made a crucial experiment in respiration: opening the chest of a dog and puncturing the lungs, he kept the animal alive by blowing a bellows over the opened thorax, thus demonstrating that the essential requirement of respiration is not movement of the lungs, but a supply of fresh air. He was a wizard in mechanics, and his inventions in flying-machines, air-pumps, watches, microscopes, telescopes, and meteorological instruments were almost countless. With equal ease and ingenuity he could speculate on the movements of heavenly bodies, and make experiments with a bubble of soap and water.

Those who came to see Hooke, attracted by his fame, must have been surprised at his appearance: he had a crooked figure with shrunken limbs, and his uncombed hair fell like a shaggy mane over an ashen countenance—and he grew smaller and more deformed with the years. His character was as unprepossessing as his body: he was too miserly to be immoral, but he was crabbed, sour, jealous, vain, and morbid. All this must be admitted, but behind those unfriendly eyes and dishevelled locks burnt the immortal fire of genius.

Hooke was not satisfied to make only half the discoveries of his age—he claimed also the other half. That is why his contemporary, Sir Thomas Molyneux, wrote of him, "Hooke, the most ill-natured conceited man in the world, hated and despised by most of the Royal Society, pretending to have all other inventions, when once discovered by their authors to the world." Hooke was indeed the gadfly of the Society, stinging even the lofty Newton into exasperation. When the *Principia* was in process of publication—at the personal expense of the abused Halley, as the Royal Society had not sufficient funds at this time—Hooke so insistently proclaimed that part of the work was stolen from him, that Newton determined to suppress a third of the volume, and would have done so, had it not been for the earnest and indignant remonstrances of Halley. Later, when Newton completed *Optics,* he ascertained that Hooke had claims upon it, and he refused to publish it during the lifetime of the curator: he kept his work in manuscript until the bitter tongue of Robert Hooke was silenced forever. Hooke had existed so sordidly as practically to deny himself the necessities of life, but upon his death several thousand pounds were found in an old iron chest whose rusty key had been unused for thirty years. His precious money he had kept to himself—only his genius he had flung into the gutters of the world.

Malpighi's next venture was in the vegetable kingdom. He had been interested in plants and trees at least since that day in Messina, when strolling with Giacomo Ruffi in the Visconte's garden, the friends found their path blocked by the overhanging branch of a chestnut-tree; Malpighi snapped and broke the bough; the way was cleared, but Malpighi did not walk on: he stood there, looking at the vascular bundles which jutted from the fractured stem. That moment a botanist was born.

After that, Malpighi watched the growth of many plants. He studied the phanerogams and the pteridophyta, the rusts and smuts, the sporangia and the mosses, mucor and other molds. He made drawings and examinations of wood and bark, of medullary rays and tracheid vessels, of sclerenchyma and rings. But Malpighi was not content to deal only with the architecture of plants: he tried to explain their physiology, and their laws of development. His views on the function of leaves in nutrition were correct. He was among the first to detect sexual differences in plants. He was the first to describe the tubercles that are produced by nitrifying bacteria on the roots of legumes. He worked out the development of ovum into seed, and of ovary into fruit. Malpighi's *Idea Anatomes Plantarum* was presented to the Royal Society in 1671, and the first sketch of it was read just as Nehemiah Grew's work on the same subject came from the press, and thus the names of the Englishman and the Italian are inseparably linked as the founders of plant morphology.

Malpighi next turned his sagacious eye upon the chick. Now the chick is an humble creature—the barnyard is its home and a worm its delicacy—but Malpighi made the chick famous: with it he created the science of embryology. He floated off the embryo in water and spread it on a glass slide, viewing the developing organs under his microscope. He described the changes he observed hour by hour. He saw and drew the formation of and closure of the medullary groove, the primitive metameres, the formation of the cerebral vesicles, the appearance of the optic vesicles with their stalk, the development of the heart from a single bent tube to the arrangement of auricles and ventricles and aortic arches—and generation after generation of medical students have followed his eye and drawn as he has drawn. In 1672 Malpighi sent this work, in two parts, to the Royal Society—*De Formatione Pulli in Ova,* in February, and *De Ovo*

Incubatio, in October. When the Fellows read it, they read the life-history of the chick: from the beginning until it is hatched, from the time that "the little opaque spot in the egg grew into a living, breathing, feathered bird."

Malpighi was now forty-four years of age, and was to do no more great work—but he rested on fadeless laurels. Even during his own lifetime, his name was honored wherever science was known. He saw his books published, not only in Bologna, but in London, Venice, Copenhagen, Leyden, Frankfort, Naples, Amsterdam, Paris and Geneva. Among his pupils were Baglivi, whose epigrams deserve to rank with those of Henri de Mondeville; and Lancisi, who demonstrated the syphilitic etiology of aneurism; and Valsalva, whose name is preserved in Valsalva's sinus, and whose method of inflating the middle ear is still used.

The inoffensive Malpighi did not come into conflict with church or state, although the blood of the sixteenth century martyrs, Servetus and Dolet and Pierre Ramus, had not yet fertilized the tree of intellectual tolerance. For the seventeenth century was ushered in with the flames that consumed Giordano Bruno; two decades later, the tongue was torn from the mouth of the valiant Vanini, and after being strangled at the stake, he was burnt; on bended knees, aged and noble Galileo was forced to recant the truth; the learned Thomasius had to flee for his life; and the fanatical Jews, not to be outdone by other religionists, sent Baruch Spinoza into exile, and drove Uriel Acosta to suicide. But fortunately for Malpighi, the sacerdotalists did not find histology heretical, nor were they frightened by the dissertation on the silkworm or by the study of the chick in the egg.

But it must not be thought that Malpighi's new ideas went altogether unchallenged. As early as 1665 the obscurantist Michele Liparo wrote a violent tract entitled *Il Trionfo dei Galenici,* which bought forth a response from Malpighi—*Il Apologia dei Moderni.* One of Malpighi's own pupils, Mini, backslid to Galenism, and lambasted his former master with

Medicus Igne non Cultro Anatomicus. In September 1687, his hereditary enemy, Professor J. Hieronymo Sbaraglia, attacked him with *De Recentiorum Medicorum Studio, Dissertatio Epistolaris ad Amicum.* His arguments have been thus summarized:

> Of what use is the knowledge of the structure of the lung and the streaming of blood through it? Everyone knows that animals breathe, but no one knows why, and it may be said even that in this modern seventeenth century, with all this new knowledge at our command, we are not even quite as successful in curing pneumonia as were the fathers of old. Everyone thought, until the work of Wirsung, that the pancreas was just a cushion to support the stomach. What better off are we to know that it has a duct? Above all, of what use to cut up plants and study the hatching of eggs? Can we cure the troubles of women, knowing how the hatching of eggs goes on?

Then came "the most unkindest cut of all"—Borelli denounced him. In his Autobiography, Malpighi refers to the matter:

> You will wonder, Reader, when I tell you that the most learned Giovanni Alfonso Borelli whom I a little while back spoke of as most anxious that my Letters should be published, now breaks out into opposition to and severe criticism of my views. The reason which has led him to do this is because the literary intercourse which existed between us having been broken off he became so inflamed with anger against me and mine that in the book which he composed in his last declining years, namely the one on the movements of animals, he seized the opportunity of disproving my opinions. In this book, he, without mentioning my name, attacks with many arguments the use assigned by me to the lungs.

In 1680 the Royal Society received another package from Malpighi, but it was not a new manuscript—it was his portrait, done in oil, by Tabor. This is the most attractive of his likenesses, for while it exhibits his serious and melancholy countenance, the sick lines of his face do not show with the pathologic vividness of some of his other portraits. That the Royal

Society framed it, is evident from a letter, which Sir Thomas Molyneux wrote to his brother at Dublin, in 1683:

> At this meeting I had the opportunity of seeing several noted men, as Mr. Evelyn, Mr. Hooke, Mr. Isaac Newton, Dr. Tyson, Dr. Slare, etc. Round the room was hung the pictures of these men: Lord Brouncker, Bishop Wilkins, Gunter the mathematician, Signor Malpighi, sent by himself from Italy, and Mr. Hobbs. Over the chimney stood their own Arms.

For many years Malpighi had lived, during the summer at least, in his villa at Corticella, on the outskirts of Bologna, and here no doubt he expected to end his days. But in April 1684 a fire leveled his cottage to the ground. This unfortunate event was witnessed by the British physician-traveler, Tancred Robinson:

> Just as I left Bologna, I had a lamentable spectacle of Malpighi's house all in flames, occasioned by the negligence of his old wife. All his pictures, furniture, books and manuscripts were burnt. I saw him in the very heat of the calamity, and methought I never beheld so much Christian patience and philosophy in any man before; for he comforted his wife and condoled nothing but the loss of his papers.

But how keenly Malpighi felt the loss can be seen by this extract from a letter to Redi:

> I live, if it can be called life, in idleness, without other aim than to distract my grief. A chance fire in my house in the last month has burnt what little I had, my notes in manuscript, the microscopes and lenses—only one was saved and a short time afterward this was stolen from me with a little money. I must recognize in this the voice of heaven, the more that to my old ills there are added articular pains which fetter me close so that nothing remains to me but to study and enjoy as best I can the work of others.

Two years passed, and as the Royal Society received no further communications from Malpighi, they collected his former works, publishing his *Opera Omnia* in two volumes, in 1686;

again two years went by without word from the great Italian, and growing anxious, the Royal Society wrote to him, telling him of the high esteem in which they held him, and asking for his most recent discoveries. Malpighi had been studying the lymphatic glands: he recognized that they formed a part of the lymphatic system, and described their distribution, consistence, form, color, relation to blood-vessels and pathologic changes, such as tuberculosis of the glands. Accordingly Malpighi sent them *Epistola de Glandularum Conglobatarum Structura,* which the Society published in 1689.

Not long afterwards, the tranquil tenor of Malpighi's life was disturbed by a startling request: Cardinal Pignatelli of Bologna became Pope Innocent XII, in 1691, and requested Malpighi to be his personal physician. A man of intrigue, who would rather play politics than pursue truth, would have accepted this offer gladly, but it could not tempt the philosopher of sixty-three who even in more ambitious days preferred the solitude of science to the flummery of courts. But Popes did not issue invitations in order to have them rejected. The seventeenth century was notorious for its professional poisoners, both male and female, particularly in Italy, and it was well for a Pope to have a reliable physician. Innocent XII wanted Malpighi, and Malpighi had to come.

Of his life in Rome, the autobiography of Malpighi says nothing, though it was noted that his health grew worse from the first year of his residence there. In 1693, the Royal Society, through its Secretary Waller, congratulated Malpighi upon his high position, but illness was penning a more fatal message. The following summer he had an apoplectic attack, and he knew that the sands of his life were running fast through the glass of time.

He hurried to put his notes in order for the Royal Society, and while thus engaged he suffered his last calamity: his wife died. They had been married for forty years, and the union, though it was fruitless, was happy; Malpighi's house was a childless house—no infants laughed and played there, no childish voice sounded through the nursery, stirring the parental heart; under its roof no boys and girls developed into men and women—but in peace and love, Marcello and Francesca had grown old and gray through the years, and now that the man was left alone, he felt himself as lost. Sixty-six is not so old, and yet the frail Malpighi had already outlived most of his contemporaries: Borelli—peace to his truculent soul!—had died of pleurisy; Descartes, Pecquet, Sylvius, Willis, Boyle, Wiseman, and Sydenham, were all dead; many workers who were born after Malpighi had already preceded him to the grave: gone were Stensen, Swammerdam, de Graaf, Mayow, and Lower.

As he lay on his death-bed, Malpighi signed his *Posthumous Works,* and directed that they be delivered to the Royal Society, which was done by Buonfigluoli. In the autumn the end came—November the twenty-ninth, 1694. Baglivi, aided by Lancisi, performed the autopsy, and both wrote detailed accounts of the findings.

Then the body of Malpighi was embalmed and brought back to Bologna, to be buried in the Church of San Giorgio. So closed the chapter of a spacious life, but before Death signed finis to the last page, the man had written across the scroll of science, several of the opening passages of modern anatomy, modern physiology, modern botany, modern histology, and modern embryology.

(1728–1793)

JOHN HUNTER

When we make a discovery in pathology, we only learn what we have overlooked in Hunter's writings or forgotten in his lectures.

JOSEPH ADAMS.

Hunter's operation for aneurism introduced into surgery an improvement which has been more fruitful in important results than any since Paré's invention of the ligature for divided arteries.

DREWRY OTTLEY.

X

JOHN HUNTER

The old Laird of Long Calderwood must have felt that he had been a sire once too often: he was nearly seventy years when his tenth child was born, and the offspring of his age was a terror: red-headed, unruly, impudent and unwilling to learn.

Every Scotch parish has its grammar-school, but little Jock Hunter had an astonishing antipathy towards teachers. And as he was extraordinarily obstinate, while his mother was unusually indulgent, he grew up unmolded by education. He was a shameful contrast to his elder brothers who were studying law, theology, and medicine. Yet folks could not consider Johnny a stupid bairn, for he was everlastingly plaguing them with questions which they could not answer. He wanted to know so many useless things—what the clouds are, and why the leaves change color in autumn, and how the tadpole becomes a frog.

It is easy enough to waste time, and at twenty John Hunter was still idle and ignorant, though quick-witted and full of fun. But he began to feel that it was time even for him to begin to do something in the world, especially as his brother William, ten years his senior, was already famous in London as a medical man. He wrote to William, asking if he might work under him—otherwise he would enlist in the army. William answered him cordially, and John Hunter mounted horse for the metropolis.

The young adventurer was poor and was seeking his fortune, but he was not exactly an Horatio Alger hero. No Sunday-school superintendent could have proclaimed him a model for youth to follow. He associated with loafers, and gave himself up to the pleasures of the flesh. Forgetting the advice of his good mother, he did not pray to be delivered from the evil of the great city, but smilingly met temptation in a rollicking spirit—with a wine-bottle in his hand and a doxy on his knee.

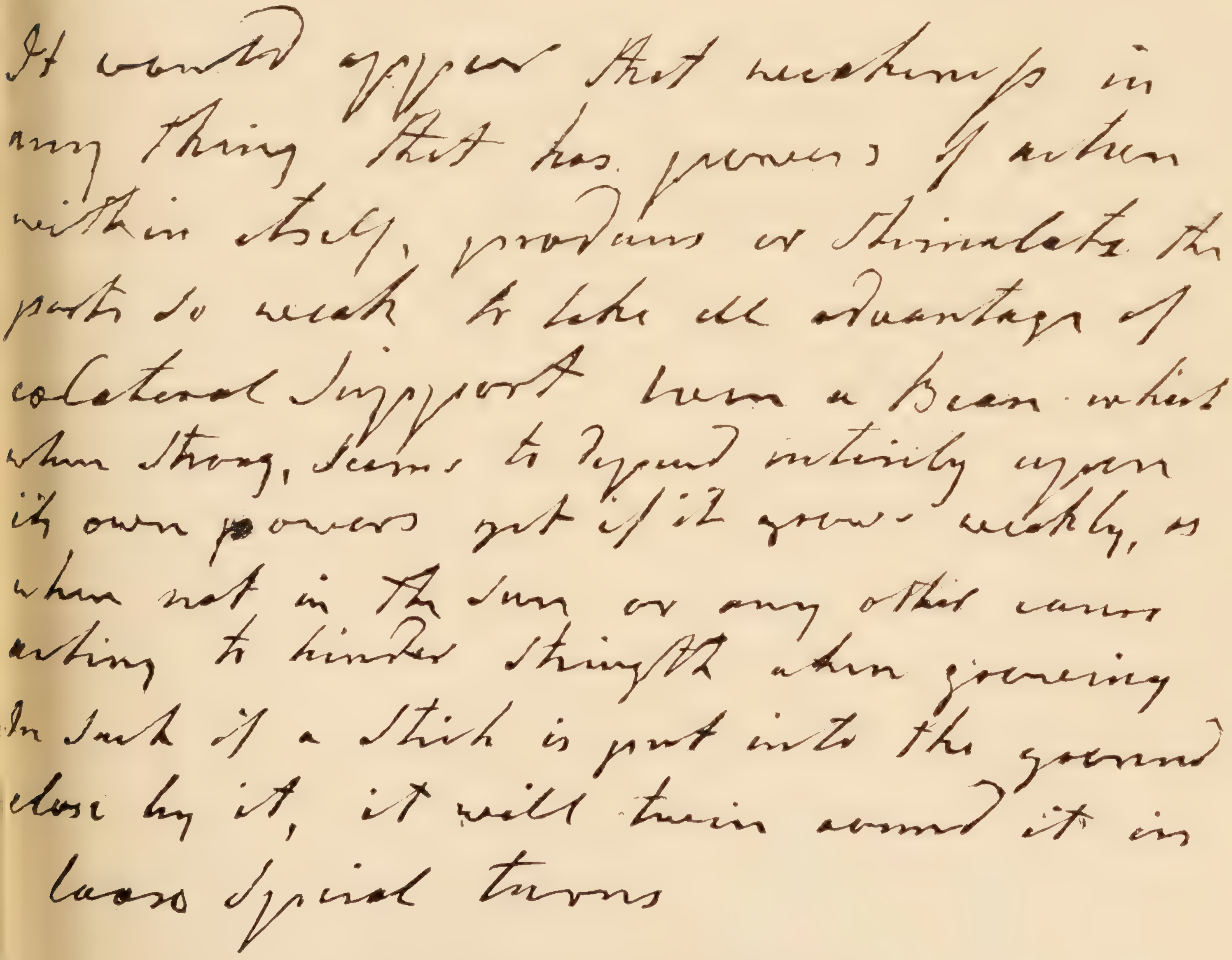
No one who saw him in the shilling gallery bawling with his companions at a production of a dramatist that displeased these critics, would have taken him for the brother of the cultured William Hunter, a typical university product, a picture of fastidiousness and finesse, well-dressed and at ease in high society, a polished agate—but John was a diamond in the rough.

William Hunter, the first great teacher of anatomy in England, was not content to illustrate his lectures with the cadavers of dogs; he employed human specimens, and after his brother came to London he thought he might engage him in the capacity of demonstrator. So he told him to try to dissect the muscles of the arm. John took the scalpel, and like another Vesalius, prepared a flawless specimen. The elegant William looked with surprise at this untrained clout who dissected so skillfully. He then gave John another arm, but with the blood-vessels injected, and this time he was to expose not only the muscles but the arteries, yet when John laid down the knife, his admiring brother informed him that he would be a good anatomist.

He now began to study at Chelsea Hospital under Cheselden, who could perform a lithotomy in fifty-four seconds, and at St. Bartholomew's Hunter became a pupil of Percival Pott—the gentleman who had such a sense of the fitness of things that he composed his *Treatise on Ruptures* when he lay in bed with a compound fracture of the leg.

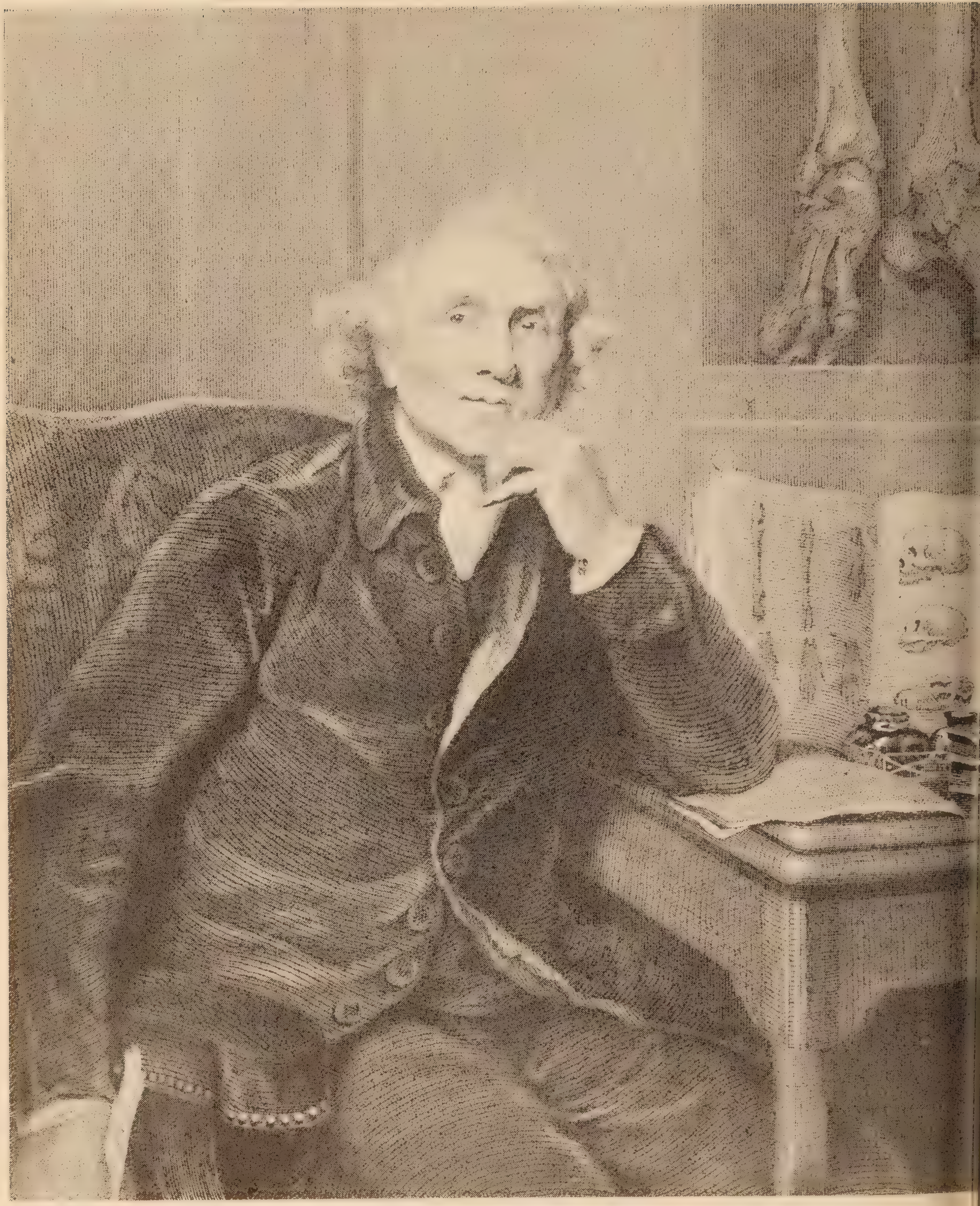
In 1753, when John was twenty-five years of age, his brother persuaded him to register as a Gentleman Commoner at St. Mary's Hall, Oxford. In less than two months John left the classic institution, but he never forgot the experience.

BIRTHPLACE OF THE HUNTERS AT LONG CALDERWOOD



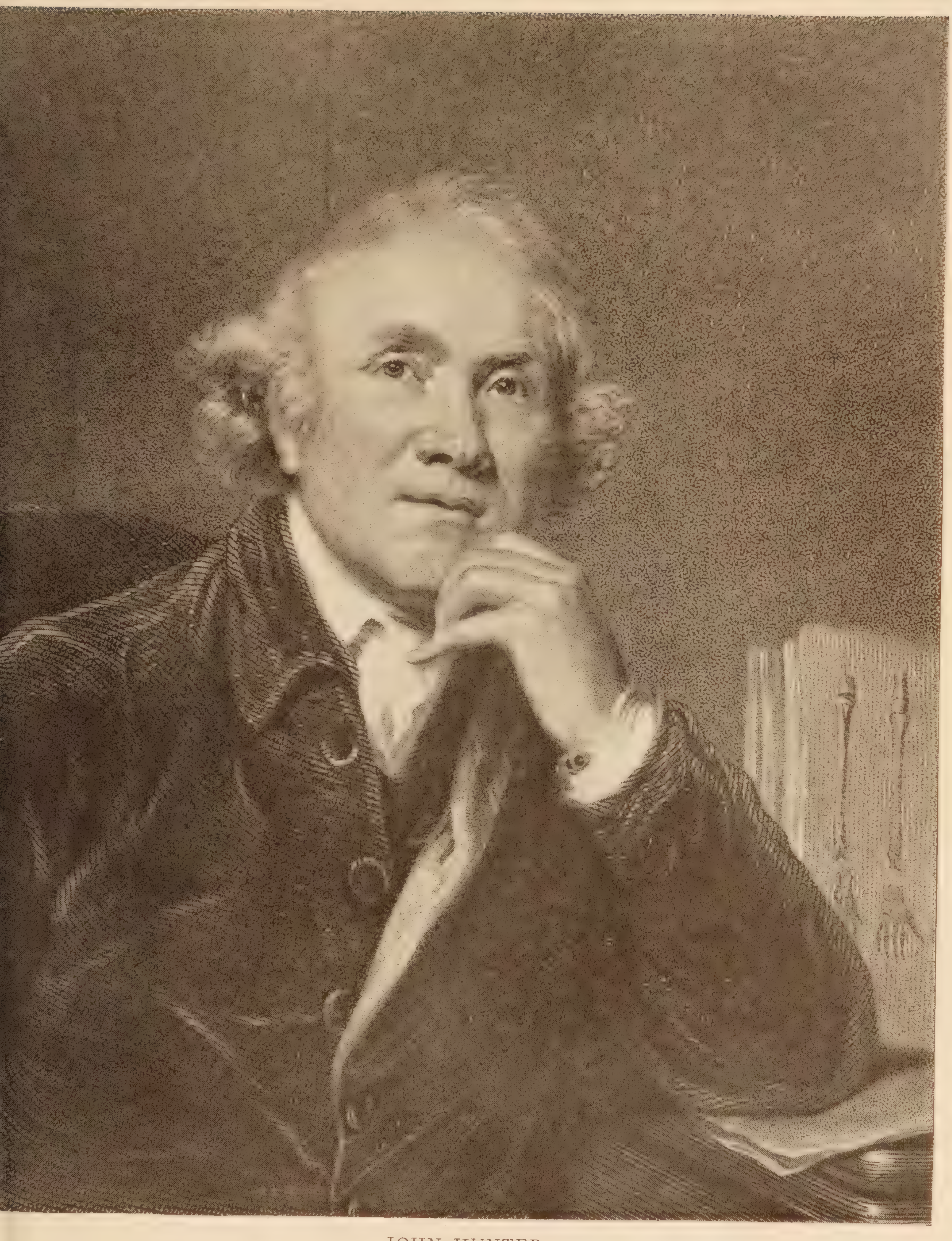
It would appear that weakness in any thing that has powers of action within itself, produces or stimulates the parts so weak to take all advantage of colateral support even a Bean which when strong, seems to depend intirely upon its own powers yet if it grows weakly, as when not in the sun or any other cause acting to hinder strength when growing In such if a stick is put into the ground close by it, it will twin round it in loose spiral turns

HANDWRITING OF JOHN HUNTER



JOHN HUNTER

The painting by Sir Joshua Reynolds, which with the exception of Jan van Calcar's woodcut of Vesalius in the Fabrica, has been reproduced more frequently than any other portrait in the history of medicine.

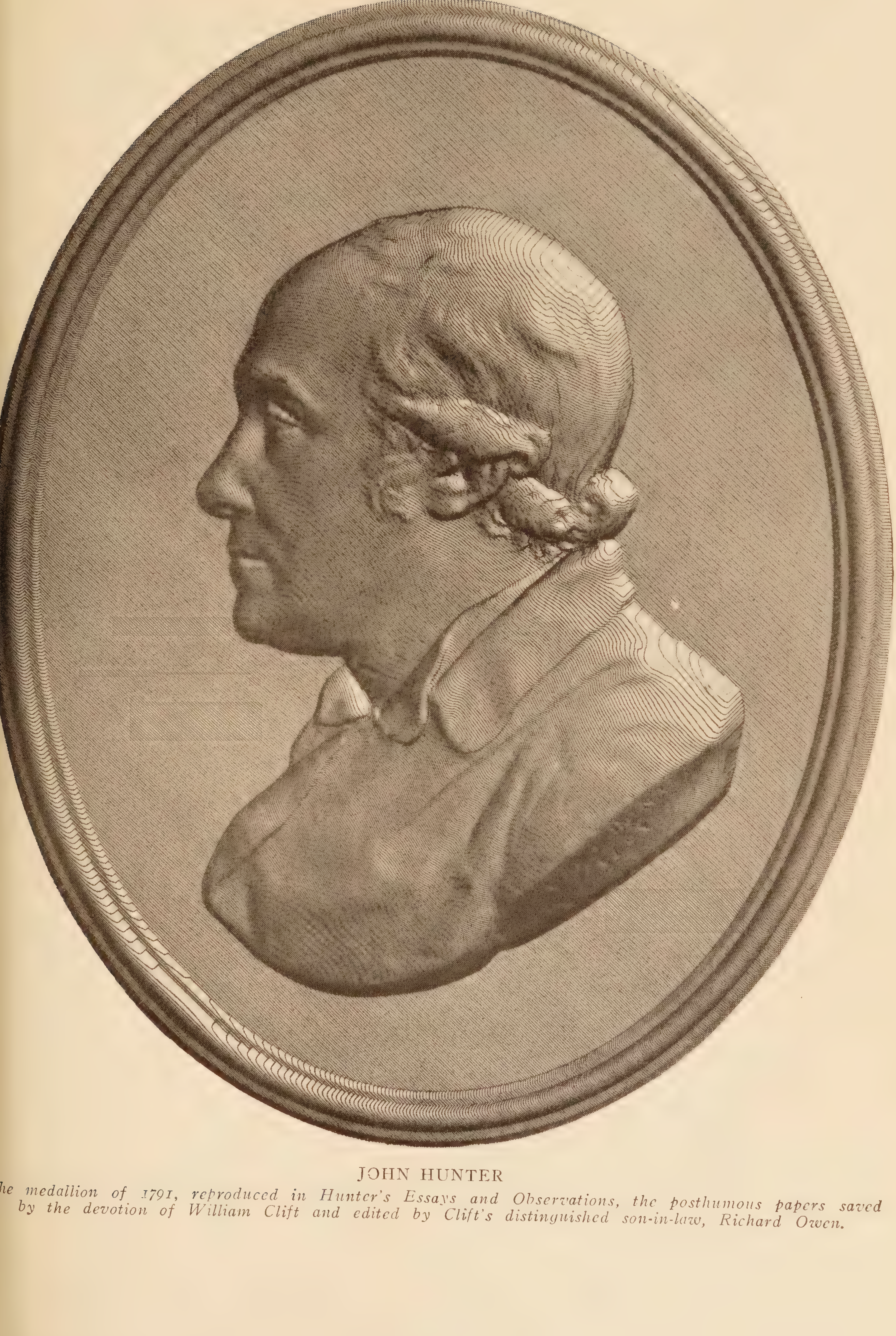


JOHN HUNTER

Engraved from the Reynolds picture by W. Holl; the engraving on the opposite page is by G. H. Adcock.

WILLIAM CLIFT IN OLD AGE

From a Lithograph in the Conservator's Room in the Royal College of Surgeons of England.



JOHN HUNTER

The medallion of 1791, reproduced in Hunter's Essays and Observations, the posthumous papers saved by the devotion of William Clift and edited by Clift's distinguished son-in-law, Richard Owen.

"Why," he used to say, "they tried to make an old woman of me; they wanted to stuff me with Greek and Latin at the University, but," and he pressed his thumb-nail on the table, "these schemes I cracked like so many vermin as they came before me."

John returned to his beloved dissecting-room, and here he learnt enough to be able to say of a rival surgeon, "Jesse Foot accuses me of not understanding the dead languages; but I could teach him on the dead body what he never knew in any language living or dead."

About this time the mode of the connection between the placenta and the uterus was discovered, but whether by William or John it is difficult to say, as both brothers claimed the honor. However, the unpleasant incident seemed to be forgotten, for in the same year, 1754, John commenced to deliver lectures in his brother's school—an occupation in which he was a failure. He never began a course without taking twenty drops of laudanum, and he read from a manuscript without daring to raise his eyes from the paper. In contrast to his brother who possessed marked oratorical ability and chose with care the exact word, John used the language of stable-boys. In speaking of syphilis, he exclaimed, "I knocked down the disease with mercury and I killed it," and in telling of a gunshot wound, he said "the ball went into the man's belly and hit his guts such a damned thump, that they mortified."

But although it is agreed that he was not a success as a lecturer, it is nevertheless true that the most serious of his pupils derived considerable benefit from his instruction. For scribbled on scraps of paper in faulty spelling and shaky syntax were brilliant observations and far-reaching generalizations which could not be found in the most elaborate text-books of the day.

Then there was an open-mindedness about Hunter that must have appealed to those of his students who relished independent thinking. "Sir," asked a pupil in surprise, "did you not say the opposite of this last year?" "Very likely I did," was the answer, "I hope I grow wiser every year." "Sir," asked another pupil, "had you not previously written—?" "Never ask me," replied Hunter, "what I have said, or what I have written; but if you will ask me what my present opinions are, I will tell you." "Gentlemen," said Hunter, when he saw his pupils taking notes, "you had better not write down that observation, for very likely I shall think differently next year."

Whatever may be said against this perplexing method of imparting knowledge, the fact remains that few teachers could point to such fruit as Hunter, for among his pupils were the foremost surgeons of the day: Astley Paston Cooper, John Abernethy, James Macartney, Anthony Carlisle, Henry Cline; John Thomson, author of the term "varioloid"; William Lynn, to whom Hunter once said when he was interrupted in his dissecting by a patient, "Well, Lynn, I must go and earn this damned guinea, or I shall be sure to want it to-morrow"; Thomas Chevalier, the well-known Professor of Anatomy and Surgery at the Royal College of Surgeons; James Wilson, the first to describe the fasciculus of the compressor urethræ since known as Wilson's muscle; Edward Coleman, the cattle's physician, author of *Anatomy and Diseases of the Foot of the Horse,* the founder of scientific veterinary surgery in Great Britain; Guy of Chichester, John Kingston, and others. Americans, too, came to study under Hunter: there was William Shippen, the first to deliver a systematic course of lectures on surgery in this country, and one of the founders of the University of Pennsylvania; and then there was Philip Syng Physick, the father of American Surgery. Physick's father brought him to Hunter and asked what books his son would be expected to read. "Sir," said Hunter, "follow me; I will show you the books your son has to study," and leading the way to the dissecting-room, he pointed to the corpses. But we have not yet named his most famous pupil and the best-beloved of all—Jenner.

As the mind of Hunter matured, his passion to study nature increased, and on the outskirts of London he managed to secure two acres which he populated with the inhabitants of rivers, mountains, jungles and deserts. These strange animals in the possession of another man would have constituted a circus, but under his observant eye they became an institute of natural history. On these grounds, sheep from Turkey and shawl-goats from the East Indies fed together, an ostrich pastured with buffaloes, and opossoms and hedgehogs—which Jenner sent—looked at zebras and sniffed at the greedy jackal. In a pond were fishes, frogs, leeches, eels, mussels. Geese and ducks waddled around, bees and wasps were there in swarms, rabbits scampered to and fro, the air was a-flutter with pigeons, a whale was dissected, and an eagle sat alone in solitary grandeur. To learn its methods of self-defense Hunter wrestled with a beautiful young bull which the Queen gave him, and in one of these frolics he nearly lost his life. From an out-house two of his leopards broke loose, and when about to climb over the wall, were carried back to their dens by the bare hands of Hunter—a perilous procedure.

John Hunter was alive; his curiosity was limitless. To see something interesting he would travel anywhere, and to obtain it he would spend, beg, coax, cajole and threaten. "Pray, George," he said to his friend George Nicol the bookseller, "have you got any money in your pocket?" "I have." "Have you got five guineas? because if you have, and will lend it to me, you shall go halves." "Halves in what?" "Why, halves in a magnificent tiger, which is now dying in Castle Street."

"I am told," he wrote to Jenner, "there is a skin of a toad in Berkeley Castle that is of prodigious size. Let me know the truth of it, its dimensions, what bones are still in it, and if it can be stolen by some invisible being. I buried two toads, last August a twelvemonth; I opened the grave last October and they were well and lively. Have you any queer fish? Write to me soon and let me have all the news."

"Come, now," said Hunter to Dr. Clarke, "I positively must have that preparation." "No, John Hunter, you positively shall not." "You will not give it to me, then?" "No." "Will you sell it?" "No." "Well then, take care I don't meet you with it in some dark lane at night, for if I do, I'll murder you to get it."

One time Hunter was arguing to be allowed to perform a post-mortem examination; with his back to the fire, and his hands in his pockets, with his feet spread apart as if to balance his anxiety, he made an earnest figure. "Then, sir," he said at last, turning to the master of the house, "you will not permit the examination to be made?" "It is impossible." "Then, sir," were the final words of Hunter, "I heartily hope that yourself and all your family, nay, all your friends, may die of the same disease, and that no one may be able to afford any assistance."

In Sir Joshua Reynolds' painting of John Hunter—that lifelike picture in which the rapt sitter seems able to break forth from the canvas at any moment—part of the background is formed by the feet of a skeleton of abnormal size. This was the skeleton of Charles O'Brien, the famous Irish giant. When the huge creature began to sicken, John Hunter cast longing eyes upon him. Hunter was a tireless worker, and for hours would stand motionless dissecting an insect in true Jan Swammerdam fashion, but after all it would be some satisfaction to trace nerves of magnitude, and to search for the pathology amid titanic organs. The giant learned that Hunter had designs upon his carcass, and to escape the anatomist's scalpel he gave orders that when he died he should be placed in a leaden coffin and sunk into the sea. But the men whom the undertaker hired to watch the eight-foot corpse, watched also the opportunity to refresh their lesser but living bodies with liquor. Hunter's servant discovered their favorite ale-house and informed his master, who came there immediately, met one of the party and offered him fifty pounds if he would allow the body to be kidnapped. The man said he must consult his companions, and returned saying that the bribe would have to be one hundred pounds. Hunter eagerly agreed, but the others were quick to perceive their advantage and these shrewd sons of Erin kept on bargaining with the scientist until finally they raised the demand to five hundred pounds. This was far more than Hunter could spare, but still less could he spare the giant's body, so he borrowed the money, and in the middle of the night the mortal remains of Charles O'Brien were conveyed to his residence, while a leaden coffin, weighted with paving stones, was sunk in deep water.

Among the many schemes that grew from Hunter's prolific brain none was greater than his idea to found a museum whose collections would illustrate all the functions of life. On the furtherance of this conception he spent much of his time and most of his money. When the Museum assumed colossal proportions, Hunter opened it for inspection during two months of the year—October for the profession, and May for "the noblemen and gentlemen who are in town only during the spring." So inconsistent is the genus homo, that although Hunter sprang from the soil, and was a rough-and-ready fellow all his life, a blunt out-spoken man hating sham, he was nevertheless one of the staunchest of Tories. He used to say that he wished all the rascals who were dissatisfied with their country would be good enough to leave it. Hunter was an innovator in surgery, but he regarded with horror an innovator in politics. In reply to a request that he permit a certain foreigner to go through his Museum, he wrote, "If your friend is in London in October (and not a Democrat) he is welcome to see it; but I would rather see it in a blaze, like the Bastille, than show it to a Democrat, let his country be what it may."

But we must see his magnificent collections, and since we may not come in with the noblemen, and it is always uncertain who is a gentleman, we will enter as members of the profession. Perhaps we will be so fortunate as to meet Blumenbach or Scarpa there.

What specimens—thousands upon thousands—dry, in spirits, stuffed,—everything: varieties of the cuticle of different animals, showing how it increases in vascularity in proportion as its sensibility increases; the organs of taste, smell, hearing and sight, exhibited in ascending series. The individual peculiarities of plants and animals, monsters, mummies, the skulls of the five great divisions of the human race, the development of the brain and spinal marrow from the knotted cord of the crustacea upwards through fishes, reptiles and birds, to the brain and spinal cord of the mammalia; teeth, from the beaks of birds to the tusks of boars; specimens showing the effects of various diseases on brains, hearts, lungs, stomachs, intestines, spleens, kidneys—the apotheosis of pathology.

But we have not yet seen the division illustrative of the function of reproduction. Here are preparations of the sexual organs in hermaphrodite plants, preparations of the organs in self-impregnating animals, and preparations of those animals which perform a double coitus. How nicely the series is arranged, first exhibiting the testes and penis in insects, then in several kinds of fishes, and numerous specimens of the testicles in the toad, showing how in the season of coupling it increases in size and is attended with an increase in the size of the tubercle of the thumb, which is employed in retaining the female. Next comes the double penis of snakes and lizards; we examine the crocodile and turtle and observe that in them it is single and begins to assume the general form which it exhibits in the mammalia; and so the specimens go on till they portray the virile organ of man. It is the shrine of Priapus.

Of course in this department are preparations of the female organs also—the pistils in plants, ovaries and ducts in molluscous animals, and then all through the scale up to the fully-developed genitalia of woman—and all the changes that occur in wombs, and the different ways in which ova are hatched, and the peculiarities of structure in the young animal during the fetal state, and the various modes in which food and protection are furnished for the young animal, as the temporary cells on the back of the pipa frog, the pouch of marsupial creatures, the nests that birds build, the glandular structure in the crop of pigeons which secretes a kind of milk, the lactiferous glands of the higher animals—and what not. The whole place is a hymn to Fecundity.

At the farthest end of the room a man is working. He is small, five feet two inches in height, but his short neck and broad shoulders give him an appearance of strength; he is dressed in a loose dissecting-apron, with the cuffs turned back; a single button holds the garment upon him. He is evidently one of the workmen around the place—let us pass on. No, there is too much intensity in that face: it is John Hunter.

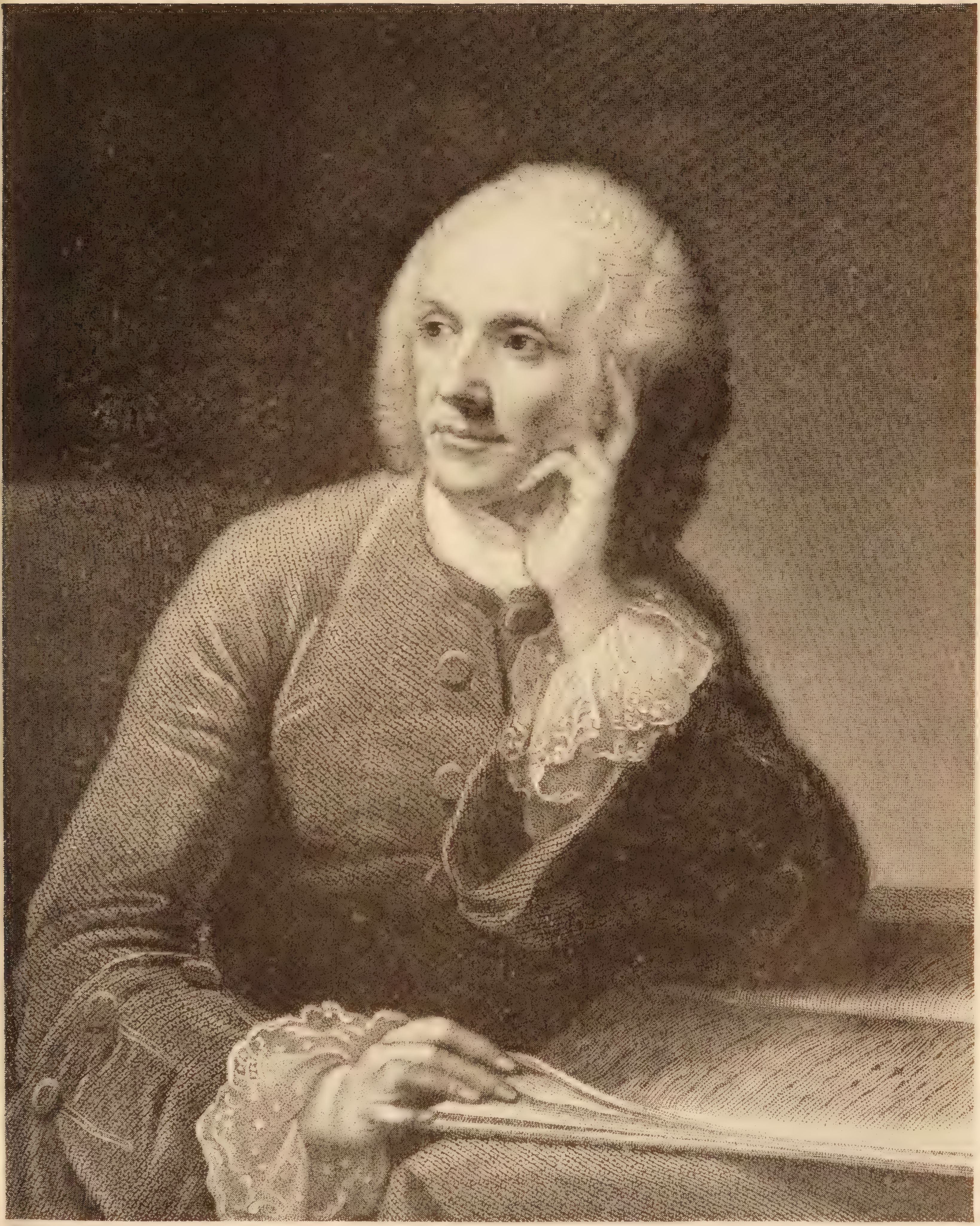
The phenomena of locomotion, digestion, absorption, circulation, respiration, etc., were illustrated in so comprehensive a fashion in the Hunterian Museum—beginning with the lowest plants and the smallest insects, and gradually leading up to the highest forms of organic life—that it is strange that the gifted founder did not hit upon the idea of Evolution. Before him lay the whole drama of development, he saw every organ in its primitive form and in its increasingly complex stages, but he did not anticipate the *Origin of Species*. Darwin quotes Hunter several times, and in the *Descent of Man* refers to him as "the illustrious Hunter," but he does not mention him as one of those who had an intimation of transformism.

But a study of Hunter's writings does reveal at least one remarkable passage which proves that if he had pursued the subject further he would be reckoned among the precursors of the theory of natural selection. "It certainly may be laid down," wrote Hunter, "as one of the principles or laws of nature to deviate under certain circumstances. It may also be observed that it is neither necessary, nor does it follow that all deviations from the original must be a falling off; it appears just the contrary; therefore we may suppose that nature is improving her works, or at least has established the principle of improvement in the body as well as in the mind."

The Museum was Hunter's church, work was his religion—and he had no other. He slept only four hours a night and napped for an hour after dinner, but all the rest of the twenty-four hours were spent in labor. If you asked for an appointment with him he was apt to tell you to meet him at five in the morning or earlier, and if you came at that hour you could find him already dissecting. "Ah, John," said old Dr. Maxwell Garthshore, "you are always at work!" "I am," was the answer, "and when I am dead you will not soon meet with another John Hunter."

He discovered much: he was forever experimenting. He had the privilege of making experiments on the deer in Richmond Park, and once he caught a buck and tied one of its external carotid arteries; he was not perplexed when the half-grown antler, which had received its blood-supply from the imprisoned vessel, became cold to the touch. But a week or two later, when the wound around the ligated artery healed, Hunter again examined the antler and was surprised to observe that it had regained its warmth and was growing. Thinking that perhaps the artery had not been sufficiently bound, Hunter killed the buck to ascertain if this was really the case, but he had done his work well: he found that the external carotid was tightly secured. But he found also that certain small branches of the artery, both above and below the ligature, had enlarged and by their anastomoses had restored the blood-supply of the developed antler. "Oho," said Hunter. "I see that under the stimulus of necessity the smaller arterial channels quickly increase in size to do the work of the larger. I must remember that."

Not many months later there lay in St. George's Hospital a patient who was looked upon as doomed: either he would succumb to popliteal aneurism, or he would perish under the surgeon's knife, for few who underwent this operation lived to undergo anything else. So frequently fatal was this operation that the profession began to adopt Percival Pott's method



William Hunter.

Portrait by Pyne, engraved by J. Thomson for J. T. Pettigrew's Medical Portrait Gallery, a much-consulted contribution to medical iconography.

—amputation of the limb above the tumor. But the physician in Hunter revolted against this idea of mutilating a man. He never regarded an operation a success if the patient rose from the operating-table a cripple. Hunter thought of his experiment with the buck—recalled that when the passage through a main trunk is arrested, the collateral vessels are capable of continuing the circulation; if, he wondered, far from the seat of the disease he fettered the artery in the sound parts where it is tied when amputation is performed, would not the absorbents be able to cope with the tumor? So in the lower part of its course in the thigh, in the fibrous sheath since known as Hunter's Canal, he ligated his patient's femoral artery. In six weeks the patient left the hospital, walking on the legs that Nature gave him and that Hunter saved for him. And following in his path, on healthy limbs, have trod thousands of men, rescued from deformity or death by this discovery of John Hunter.

Writing was a hardship to Hunter, and his friends had to be called in to correct his spelling and strengthen his grammar, but he left behind him a considerable list of publications. In 1767 he was elected a F.R.S. and he contributed many papers to the *Philosophical Transactions* of the Society. Among these valuable memoirs we may mention: *Anatomical Observations on the Torpedo; Observations on the Gillaroo Trout; An Account of the Gymnotus Electricus; Experiments on Animals and Vegetables with Respect to the Power of Producing Heat; Proposals for the Recovery of People Apparently Drowned; An Account of the Free Martin; Account of the Organ of Hearing in Fishes; Observations Tending to Show that the Wolf, Jackal and Dog are All of the same Species; An Experiment to Determine the Effect of Extirpating one Ovarium upon the Number of Young Produced; Observations on the Structure and Economy of Whales; Observations on Bees; Observations on Fossil Bones.* The modest titles of these essays do not suggest, even faintly, the scope of thought or the amount of experimentation that went into their making; for instance the paper on the Bees was the result of twenty years of the hardest thinking and the most careful kind of original research. All his books were of great importance: *A Treatise on the Natural History of the Human Teeth; A Treatise on the Venereal Disease; Observations on Certain Parts of the Animal Economy; A Treatise on the Blood, Inflammation, and Gunshot Wounds.*

Most of his books were printed in his own house by compositors in his own service. In adopting this plan Hunter evinced much wisdom, for he was an impatient hot-headed man afflicted with angina pectoris, and he would never have lasted long if he had permitted himself to be worried by the aggravating tribe of type-setters and bookbinders.

It was in May 1771 that Hunter's first book appeared, and two months later he married Miss Anne Home, spending the proceeds of the publication upon the event, which indicates that it must have been a very modest wedding. He announced the news to William in the following letter:

> Dear Brother—To-morrow morning at eight o'clock and at St. James's Church I enter into the Holy State of Matrimony. As that is a ceremony which you are not particularly fond of, I will not make a point of having your company there. I propose going out of town for a few days; when I come to town I shall call upon you. Married or not married, ever yours, JOHN HUNTER.

Hunter was forty-three at this time, his wife was twenty-nine. Anne was quite a personality—not a mere housekeeper. She was amiable and beautiful and clever; her poems were published in a volume. Her impassioned tribute to the memory of young Chatterton should be remembered by all who venerate the genius of that unfortunate poet who was forced to slay himself at the age of seventeen, but whose name will never disappear from English literature. It was Mrs. Hunter who supplied the words for Haydn's *Creation,* and she likewise furnished the verses for several of the Austrian composer's canzonets. As an example of her style, let us quote one of these pretty songs:

My mother bids me bind my hair
  With bands of rosy hue,
Tie up my sleeves with ribbons rare,
  And lace my bodice blue.

For why, she cries, sit still and weep,
  While others dance and play?
Alas! I scarce can go or creep,
  While Lubin is away.

'Tis sad to think the days are gone,
  When those we love were near;
I sit upon this mossy stone,
  And sigh when none can hear.

And while I spin my flaxen thread,
  And sing my simple lay,
The village seems asleep or dead,
  Now Lubin is away.

Ottley says Anne was "a little of a *bas bleu,*" which is not so bad, however, as being *mauvais ton.* Ottley also relates this interesting domestic incident: "Mrs. Hunter was rather fond of gay society, a taste which occasionally interfered with her husband's more philosophic pursuits. On returning home late one evening, after a hard day's fag, Hunter unexpectedly found his drawing-room filled with musical professors, connoisseurs, and other idlers, whom Mrs. Hunter had assembled. He was greatly irritated, and walking straight into the room, addressed the astonished guests pretty much in the following strain: 'I knew nothing of this kick-up, and I ought to have been informed of it beforehand, but as I am now returned home to study, I hope the present company will retire.' " Ottley adds that this intimation was speedily followed by an *exeunt omnes*—but he does not report what happened when the charming heroine and the irate villain were left alone.

There is in existence a letter by Anne Hunter, written at Bath, which is worth reading because it was addressed to Edward Jenner and because it exhibits John Hunter in repose:

Dear Sir—I take it for granted you will not feel sorry to hear Mr. Hunter is so near you, though you will lament that loss of health is the occasion. He has been tormented with a flying gout since last March, and we are come here in hope of some favorable crisis before the winter. He has been inquiring for the post to Berkeley, and I find within this hour that it goes off this evening; as he is now asleep after dinner, I rather write myself than disturb his nap, to inform you of our being in your neighborhood, and that Mr. Hunter will be glad to hear from you. I am, dear Sir, your obedient Servant, A. HUNTER.

We have given several instances of Hunter's hasty temper, but it must not be supposed that, like Thomas Carlyle, he was in perpetual ill-humor. He was naturally benevolent, and was beloved by those who were not jealous of him. He often returned a fee if he thought the patient could not afford payment, and when patients told him outright that they had not a shilling, he did not remind them there were other physicians in town. Frequently he would let his rich patients wait while he attended to the poor, saying that the grandees had nothing to do anyway, while to the poor, time was money. It is true, like most men he hated to be contradicted, but as his brother William said, this is a special characteristic of anatomists because they grow accustomed to the passive submission of dead bodies. Nor must it be forgotten that for years Hunter was a sick man; he toiled at his labors harder than the Titans piling mountains upon mountains, but a terrible ailment racked his body: not only did he suffer from gout, but angina pectoris—that agonizing breast-pang which cramps the heart with excruciating pain—was ever ready to attack him. Had his health been better, no doubt he would have been less testy. Hunter well knew that it was dangerous for him to become choleric, and he used to say, "My life is in the hands of any rascal who chooses to annoy and tease me."

One of these paroxysms was witnessed by his brother-in-law, Everard Home, who vividly describes his condition: "I was with him during the whole of this attack, and never saw anything equal to the agonies he suffered; and when he fainted away, I thought him dead. These affections at last seized him when lying in bed, and in his sleep, so as to waken him. The exercise that generally brought on the spasms was walking, especially on an ascent, either of stairs or rising ground; the affections of the mind that brought them on were principally anxiety or anger; the anxiety about the swarming of a hive of bees brought it on; the anxiety lest an animal should make its escape before he could get a gun to shoot it, brought it on; even the hearing of a story would bring it on; anger brought on the same complaint, and he could conceive it possible for that passion to be carried so far as totally to deprive him of life. But what was very extraordinary, the more tender passions of the mind did not produce it; he could relate a story which called up the finer feelings, as compassion, admiration for the action of gratitude in others, so as to make him shed tears: yet the spasm was not excited."

In 1780 occurred the most lamentable and inexplicable episode in the lives of the illustrious brothers. John communicated to the Royal Society a paper on *The Structure of the Placenta,* which began, "The connection between the mother and the fetus in the human subject has, in every age in which science has been cultivated, called forth the attention of the anatomist, the physiologist, and even the philosopher; but both that connection, and the structure of the parts which form the connection, were unknown until about the year 1754. The subject is certainly most interesting, and the discovery important; and it is my intention, in the following pages, to give such an account of it as I hope may be acceptable to the public; while, at the same time, I establish my own claim to the discovery."

In reply to this paper William wrote to the Society asserting that it was he who had made the discovery, and that it could be found in his *Anatomy of the Gravid Uterus.* John wrote again, reaffirming his claim, and furnished more particulars about the matter. The Royal Society was then requested to settle the honors between them, but the Council flatly refused to publish John's paper or to take any cognizance of the fraternal quarrel.

But what on earth had induced John Hunter to bring up again a sore subject more than a quarter of a century old? Because, said Gossip, he was angry at his brother who was angry at him because he married Miss Home. But the elusive and slippery facts we do not know. Thus the brothers parted company; it was shameful, almost as scandalous as the action of John Bernoulli who expelled his son Daniel from the house because the young man won the prize of the French Academy which the father himself coveted.

Three years later William Hunter was severely ill, but against the advice of friends he insisted on attending his classes; during the lecture he began to die, but that well-trained voice delivered its sonorous sentences; the discourse ended, the doctor bowed to his students—and fainted from exhaustion. He was taken home, and in the night he was smitten with a paralytic stroke. When John heard of this, he knew it was time to swallow his pride, and he asked and received permission to visit William. So the brothers met again —but the elder lay on his death-bed. He died as gracefully as he lived. "If I had strength enough to hold a pen," were his last words, "I would write how easy and pleasant a thing it is to die." On Sunday, March 30, 1783, in the sixty-fifth year of his age, he passed away. John was not mentioned in the will—not even the old homestead of Long Calderwood was left to him.

Ten years later John Hunter himself was sixty-five years old. He was a distinguished man: Fellow of the Royal Society, Member of the Irish College of Surgeons, Member of the Chirurgo-Physical Society of Edinburgh, Surgeon-General to the Army, Inspector-General of Hospitals, Surgeon to St. George's Hospital, Surgeon-Extraordinary to the King, etc., etc. On no occasion, however, did he append any of these useless titles to his name; in all his writings he proudly signed himself—John Hunter.

For the last twenty-five years he was on the staff of St. George's Hospital. The reason he served so long was because his colleagues couldn't oust him. They could never get along with Hunter, and they did not see why he received more pupils than they did, and besides they wanted to know what business had a surgeon to waste so much time in physiological researches. "His museum," remarked one of his associates, "is of as much use as so many pigs' pettitoes." And Hunter was not biblical, and did not believe in the soft answer that turneth away wrath.

Disputes developed, angry letters were written back and forth, and often the Governors were asked to interfere, and they did so by uniformly deciding against Hunter—a circumstance which did not tend to make him imitate a turtle-dove. He was of an imperious nature, and his high spirit chafed under his defeats.

In the early autumn of 1793 his colleagues adopted a resolution: no pupil could be received into the hospital unless he had a certificate proving that he had been bred up to the profession. This was considered a slap at Hunter, who was no stickler for such things, and would accept all pupils who seemed promising, even if they lacked previous education: perhaps he remembered his own case. Not long after this rule went into effect, two young men without certificates came to Hunter and asked to be admitted under him at the hospital. "I'm sorry," said Hunter, "but—well, suppose you write out your case; to-morrow we have a meeting of the Board, and I'll do what I can for you. Perhaps they'll let you in."

On the morrow Hunter was in admirable humor. He was growing old and was somewhat of an invalid, but his hand had not lost its cunning: that morning he had made a dandy dissection—just what he needed for the Museum. He radiated good cheer. He strode into the work-rooms and told his resident-pupils some funny stories how children counterfeit illness—for certain purposes. His pupils laughed.

Hunter was so pleased with himself that he forgot to take his visiting-list along when he left his home—whistling a Scotch air as he went. But William Clift, the Cornish lad who idolized Hunter, saw that York Street was the first place on the list and he ran there with the day's schedule. He found Hunter's carriage waiting, and soon Hunter himself came out of the house. Clift handed him the record of appointments, Hunter took it, looked it over, and in a ringing voice told the coachman to drive to the hospital.

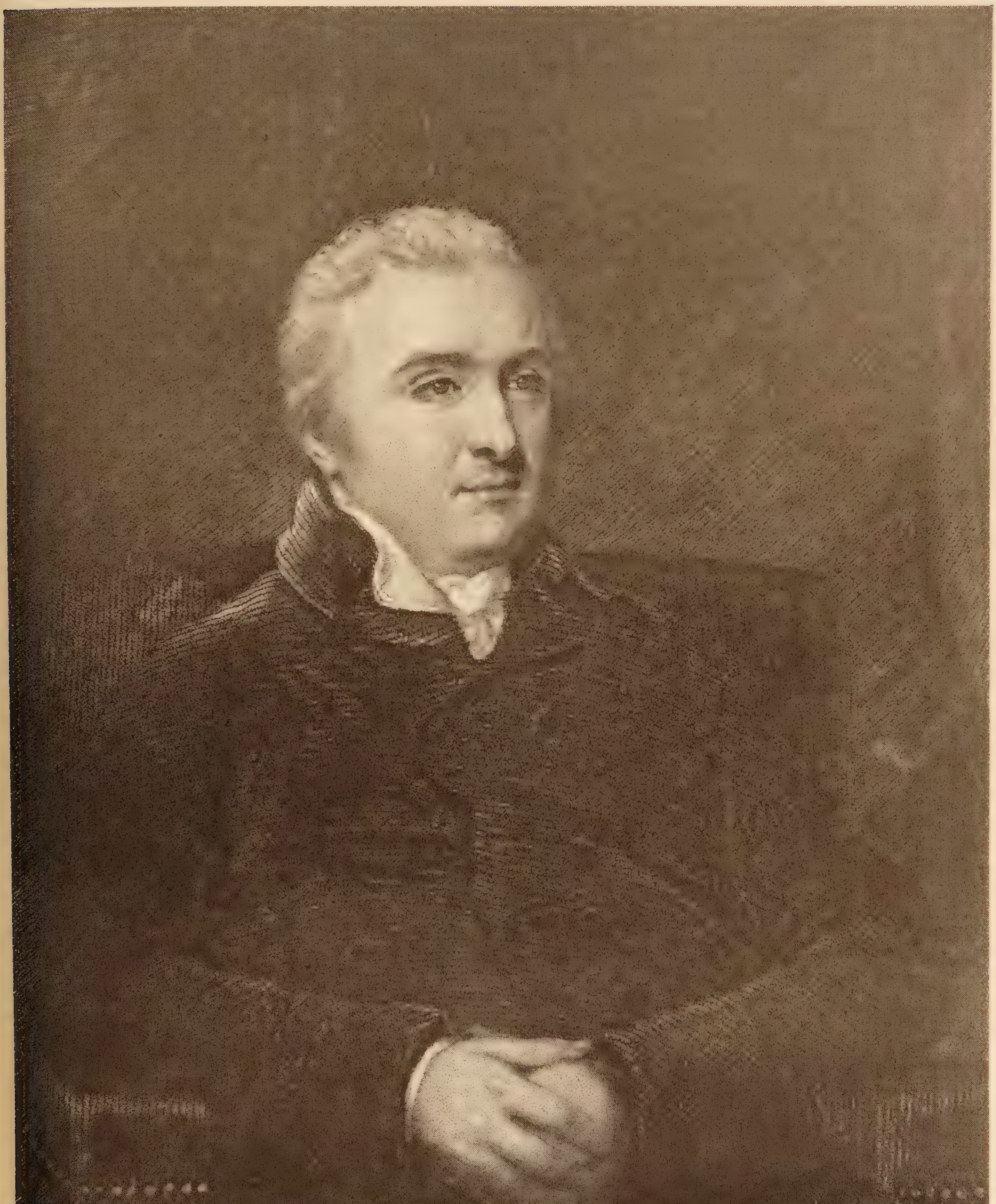
He entered. The meeting had already begun; Hunter sat down; he spoke in behalf of the young men. Instantly a colleague opposed him. Choking with pain and rage John Hunter arose; he turned toward the next room, and Dr. Robertson and Matthew Baillie followed him; Hunter uttered a groan and staggered into Dr. Robertson's arms. Everard Home, who was in the hospital, was sent for. Hoping that he had only fainted, they worked upon him for over an hour; but life had fled. He was murdered by an insult—with the aid of angina pectoris. The visiting-list was in his pocket, but the remainder of his appointments were cancelled. The Board broke up, inserting the following notice in its minutes:

> RESOLVED—That Mr. Hunter's letter to this Board relating to two of the surgeon's pupils, which was received this day, be preserved for future consideration.

The feet of horses were heard in Leicester Fields; Mrs. Hunter looked out of her window and saw an empty carriage.

She much desired that her husband repose in Westminster Abbey, but it was not to be; he was interred in St. Martin's-in-the-Fields. Long afterwards she composed to his memory an Epitaph:

Here rests in awful silence, cold and still,
  One whom no common sparks of genius fired;
Whose reach of thought Nature alone could fill,
  Whose deep research the love of Truth inspired.



MATTHEW BAILLIE

Hunter! if years of toil and watchful care,
  If the vast labors of a powerful mind
To soothe the ills humanity must share,
  Deserve the grateful plaudits of mankind—

Then be each human weakness buried here
  Envy would raise to dim a name so bright:
Those specks which in the orbs of day appear,
  Take nothing from his warm and welcome light.

By the terms of the will, his nephew, Matthew Baillie—the last medical man in London who carried the famous gold-headed cane—and his brother-in-law, Sir Everard Home, were appointed executors. After the elapse of some years Home insisted on having all of Hunter's unpublished manuscripts—he said he needed them to prepare the Catalogue of the Hunterian Museum—and William Clift who had guarded them so faithfully put them in a cart and conveyed them to Sir Everard.

Men began to speak of the greatness of Everard Home. He contributed more papers to the Royal Society than any other member, and these communications were remarkable for their breadth of vision and for the number of discoveries they contained. "He inherits the mantle of John Hunter," they said.

The trustees of the museum grumbled; they urged Home to get the Catalogue ready; it was more than time. "If you are too busy with your important researches," they suggested, "let someone else do it." "Nonsense," answered Sir Everard, "I will prepare the Catalogue myself." And the ambitious investigator kept on reading papers before the Royal Society, and men said of him, "He is a second John Hunter."

In July 1823 Everard Home received from the printer the last proof of his concluding volume of *Lectures on Comparative Anatomy.* Sir Everard was ageing, and knew that death might take him unawares, but as he did not wish men to know that for years he had been stealing from John Hunter's manuscripts, he placed these priceless papers upon his hearth. Flames leaped up the chimney; so much smoke was made that the engines came, and firemen demanded entrance; but Modred calmed them: the house was not on fire—it was only John Hunter's manuscripts burning.

The case came to court, and Sir Everard defended himself by saying that Hunter had commanded him to destroy the manuscripts as they were in too imperfect a form for the public. Among those who tried to testify against Sir Everard was poor Clift—but he broke down and cried.

But William Clift had done a deed that makes posterity bless his name. During the period that this devoted boy had access to the manuscripts, he frequently read and made extracts from them—with his own hand he copied nine folios. And many years later, his son-in-law, the distinguished Sir Richard Owen, edited these notes in two volumes, entitled, *John Hunter's Essays and Observations on Natural History, Anatomy, Physiology, Psychology, and Geology*—and even Darwin quoted from them. It is very probable that among the ashes of his manuscripts were anticipations of evolution.

Clift was noted for his beautiful penmanship, and he drew so skilfully that he was called upon to illustrate the *Morbid Anatomy* of Matthew Baillie, but he is remembered chiefly as the most faithful curator in history. By living for more than half a century in the greatest of universities—the Hunterian Museum—he acquired such knowledge of science that he was able to help a Brodie in anatomy, a Lyell in geology, and a Cuvier in paleontology. No wonder Sir Humphry Davy insisted that he be elected a Fellow of the Royal Society. It was noticed as he grew older that he resembled Hunter in appearance, and when this aroused suspicion, William Clift—who had been so humble and poor that servants looked down upon him—answered proudly: "If I thought what you insinuate were true, there is not a Duke in all England I would touch my hat to."

As the years rolled by, the British nation awoke to the fact that the fitting resting-place of so great a man as Hunter was Westminster Abbey. But his body had long lain in the vaults of St. Martin's-in-the-Fields. Who could locate his coffin among thousands? "I will find it," said Frank Buckland. He spent sixteen days in the charnel-house, examining over three thousand coffins—and found it. With more honor than he ever received during his lifetime, John Hunter was buried in the North aisle of the great Abbey, and on perennial brass were inscribed the words, The Founder of Scientific Surgery. This aisle is a veritable shrine of science, for besides John Hunter it now contains the remains of Newton, Darwin, Herschel, Lyell, Woodward, Mead, Couch Adams and James Prescott Joule. The wishes of John Hunter's widow were at last fulfilled, but she never knew it: so many good things in this world come too late.

The fame of Hunter has increased with the passing of the years. Every Hunterian Oration is eloquent—as eloquent as the orator can make it—in praise of his genius, and Samuel D. Gross has left this line on record: "With the exception of Hippocrates, the father of Medicine, John Hunter is the grandest figure in the history of our profession."

The Life of Hunter has been written several times: pathologically by Everard Home, cleverly but maliciously by Jesse Foot, eulogistically by Joseph Adams, colorlessly by Stephen Paget, more satisfactorily by Drewry Ottley, but the only adequate sketch of his mental career occurs in Henry Thomas Buckle's *History of Civilization.*

It must not be thought, however, that we believe in the chasm which Buckle imagines to exist between the deductive and inductive method. According to Buckle, the Scotch are the most deductive people on earth, while the English are the most inductive, and therefore, he argues, since Hunter spent the first twenty years of his life in a deductive country and the remainder in an eminently inductive nation, it follows that the two hostile forces of deduction and induction struggled for the mastery in his mind and at times obscured his understanding.

We can answer this argument with an incident from the historian's own life: When Buckle was a chess-player he occasionally met in the cigar-divan of the Strand a youth of his own age. Some years later this young man decided to publish a series of books by subscription, and Buckle was among the first subscribers. If Buckle had not died in his prime he would have received the volumes of the *Synthetic Philosophy,* beyond all peradventure the vastest deductive work ever conceived—but generated and accomplished, not in a Scotch, but in an English brain.

This then is the stricture that we would pass on Buckle's examination of Hunter's intellect, but in all other respects we pronounce it a far abler and more comprehensive sketch than has been written by any medical man; the passage on Hunter as a pathologist is especially superb.

Among the speculations which had engaged Hunter's mind was the possibility of scientifically freezing human beings, and warming them back to life a century or two afterwards. But though he pursued the subject so far as actually to experiment on animals with this object in view, his ingenious project, like Leonardo da Vinci's ambitious plan to remove mountains by the laws of physics, never materialized. On the whole we need not regret that he failed in this respect, for it is with considerable trepidation that we would view the rebirth of some of Hunter's contemporaries; for instance, Samuel Johnson, the arch-obscurantist, nor would we care to listen again to Edmund Burke's puerile lament of mankind's ingratitude toward queens.

But how well it would have been if John Hunter himself, instead of perishing in a passion, had been congealed, and if now, after an hibernation of 120 years, he could be thawed out and live once more among us. How eagerly we would press around the master, and how much his disciples would have to show him. But not long could we prattle, for John

Hunter would grow impatient, and we would soon see him lost in thought, as when he sat before Sir Joshua's brush, or we would find him with rolled-up sleeves in a laboratory, working over the great modern problem of cancer.

(1749–1823)

EDWARD JENNER

Medicine has never before produced any single improvement of such utility. Harvey's discovery of the circulation of the blood was a beautiful addition to our knowledge of the ancient economy; but on a review of the practice of medicine before and since that epoch, I do not see any great amelioration which has been derived from that discovery. You have erased from the calendar of human afflictions one of its greatest. Yours is the comfortable reflection that mankind can never forget that you have lived; future nations will know by history only that the loathsome smallpox has existed, and by you has been extirpated.

THOMAS JEFFERSON: *to Edward Jenner.*

XI

EDWARD JENNER

I

Let us not mourn at the mystery which surrounds the life of Mary Wortley Montagu, for although it is true that we cannot ascertain whether the honorable lady ever entered a harem and saw the Sultan's animated aphrodisiacs, it is equally true that the matter is of no consequence, while what we do know of her is of the utmost importance: that during the second decade of the eighteenth century, while residing at Constantinople in the capacity of the British Ambassador's wife, she observed the Turkish practice of inoculating against smallpox.

Most Englishwomen of that period would have scorned to adopt the ways of the heathen, but Lady Mary had eloped from the parental home, and a woman who elopes is apt to be unprejudiced. The chief fault of such women is that twenty years later they object to their daughters following in their flying footsteps.

In one of those gossipy letters which have gained her a place in literature by the side of Madame Sévigné, Lady Mary writes:

> I am going to tell you a thing that I am sure will make you wish yourself here. The smallpox, so fatal, and so general amongst us, is here entirely harmless by the invention of ingrafting, which is the term they give it. There is a set of old women who make it their business to perform the operation every autumn, in the month of September, when the great heat is abated. People send to one

another to know if any of their family has a mind to have the smallpox; they make parties for this purpose, and when they are met (commonly fifteen or sixteen together), the old woman comes with a nut-shell full of the matter of the best sort of smallpox, and asks what veins you please to have opened. She immediately rips open that you offer to her with a large needle (which gives you no more pain than a common scratch), and puts into the vein as much venom as can lie upon the head of her needle, and after binds up the little wound with a hollow bit of shell; and in this manner opens four or five veins. The Grecians have commonly the superstition of opening one in the middle of the forehead, in each arm, and on the breast, to mark the sign of the cross; but this has a very ill effect, all these wounds leaving little scars, and is not done by those that are not superstitious, who choose to have them in the legs, or that part of the arm that is concealed. The children or young patients play together all the rest of the day, and are in perfect health to the eighth. Then the fever begins to seize them, and they keep their beds two days, very seldom three. Every year thousands undergo this operation; and the French ambassador says pleasantly, that they take the smallpox here by way of diversion, as they take the waters in other countries. There is no example of anyone that has died in it; and you may believe I am very well satisfied of the safety of this experiment, since I intend to try it on my dear little son.

Oddly enough, the recipient of this information, Miss Sarah Chiswell, later succumbed to the smallpox—and yet not so oddly for in those days to die from smallpox was almost the natural manner of dying. The "dear little son" in the case was duly and successfully inoculated, and lived to become a big scoundrel.

On her return to England in 1722, Lady Mary introduced inoculation by submitting her daughter to the test. The vivacious authoress complained she would like to communicate with the physicians on this topic if she knew any "who had virtue enough to destroy such a considerable branch of their revenue for the good of mankind," but her first disciple was a physician: Dr. Keith of London, who also inoculated his own daughter. From that time on, the practice of inoculation came into vogue in England.

But this production of a modified form of smallpox in order to secure exemption from a more malignant attack, proved to be only a mixed blessing at best, for the inoculated person became a source of danger to his unprotected neighbor. The inoculated smallpox was fully as infectious as the natural variola, and while it conferred immunity on those who availed themselves of the practice—though often with more suffering than Lady Mary's letter would lead us to suppose—it spread the disease to great numbers who had not been inoculated. So while with one hand it did good, with the other it committed evil; it saved the individual and menaced the community. Mankind felt that a better prophylactic must be discovered before it could cease to consider the smallpox the worst of diseases.

The story of inoculation has been submerged in a greater preventive method, yet its development and decline are replete with interest: inoculation as mentioned in the Sanskrit Vedas, employing "variolous pus moistened with water from the sacred Ganges"; the African method of incisions between the fingers, the Chinese method of "pock-sowing," and the European method of "buying the smallpox"; the sagacious verses of the School of Salerno; the pamphlet warfare fought over inoculation; Cotton Mather's inoculation of negroes; Zabdiel Boylston of Boston hiding from a threatening mob; the renowned Mead experimenting on condemned criminals of Newgate; Catherine the Great being inoculated upon the recommendation of Voltaire; the nobles of Russia undergoing the operation at the hands of Dimsdale; inoculation spreading in all countries, and the clergy quoting Scripture against it; inoculation introduced into Naples by an active practitioner and professor of medicine, author of many well-written volumes, eminent as syphilographer, botanist and entomologist—such was Domenico Cirillo.

In the past, the European nations were regarded as the private property of their rulers, and the citizens were virtually serfs. It was therefore inevitable that monarchs should indulge in unrestrained cruelty and unbridled debauchery—in similar circumstances, all other men would do the same. Royal blood is a stupid myth, and any peasant elevated to power at once acts as if born to the purple. Throughout this period, however, there was one family which became peculiarly notorious for its murderous propensities and uniformly hateful qualities—and among the worst of these Bourbons was the fourth Ferdinand of Naples. The verdict of history is expressed by Luigi Villari: "Few sovereigns have left behind so odious a memory. His whole career is one long record of perjury, vengeance and meanness, unredeemed by a single generous act." His systematic efforts to exterminate the last vestige of decency from his kingdom naturally bred revolt, and when the Parthenopean Republic was proclaimed, the king fled in fear to Palermo. He sent the lazzaroni and an army of convicts under Cardinal Ruffo against the new republic, which unable to endure the unspeakable barbarities, accepted Ruffo's terms of capitulation: the rebels agreed to abandon their fortress and seek exile in France. Thirty-six hours later, the exquisite hand of Lady Hamilton lightly broke this agreement—

The illiterate daughter of a Cheshire blacksmith, engaged in dubious occupations from her early childhood, bearing the first of her illegitimate children at the age of fifteen and passing from gentleman to gentleman, she tarried awhile with the Honorable Charles Greville. This man-about-town employed her in her usual capacity, but was sufficiently interested to teach her to sing, dance and act, and further showed his devotion by hiring her mother, under the name of Mrs. Cadagon, as the household servant. Now Greville's uncle, the cultured and fastidious Sir William Hamilton, diplomatist, archæologist, collector of rare merit—he was one of the founders of the British Museum—all-around connoisseur and best dancer of the Neapolitan court where he served as British ambassador, visited England on leave, and saw the beautiful treasure beneath his nephew's roof. Hamilton, a widower of fifty-four, exclaimed with honest enthusiasm, "She is better than nature and finer than anything in antique art." A gentleman's arrangement was effected, whereby the uncle paid the debts of the nephew, who in turn generously relinquished his mistress.

At first it was not Sir William's intention to marry this ex-barmaid of uncounted adventures, but she had reasons for deciding otherwise. Amid the depravity of Naples, Lady Hamilton reached heights that would have been inaccessible to her in England. She became the intimate friend and confidante of King Ferdinand's attractive consort, and while Maria Carolina was Queen of Naples, Lady Hamilton reigned as the Cleopatra of the Mediterranean. There may be no conclusive evidence that in earlier days she had posed as the Goddess of Health on quack Graham's Medico-Magnetico-Musico-Electrical Bed, but her tableaux-vivants at Naples were the talk and admiration of Europe. Her "wondrous beauty" was on all lips; poets, artists, musicians, princes, openly worshipped her. The mighty Goethe, lingering five weeks by the Vesuvian Bay, "was captivated by her grace, as she moved through the mazes of the shawl dance she made famous." The lovely creature was the conqueror of all men, but her chief captive was Horatio Nelson, fresh from his Egyptian victory. To be with Lady Hamilton, Lord Nelson defied the world: he treated his wife with revolting brutality, betrayed his friend Sir William, and scorned the orders of his government. The Admiralty would have made short work of Nelson at this time, but the Napoleonic menace loomed over Europe, and the hero of the Nile was considered indispensable.

Nominally he was a British admiral, in reality he became the butcher of the Bourbons. With vulgar jokes about cutting off heads, he hastened to prevent any mercy to the defeated defenders of the Parthenopean Republic. Cardinal Ruffo, despite his harshness toward liberalism, informed Nelson it was impossible to violate a definite agreement. Thereupon Nelson sulkily feigned to accept the terms, and under promise of life and liberty, the rebels were conveyed to his fleet. Lost to all honor, Nelson now prepared a carnival for the Neapolitan court: the British squadron was turned into torture-chambers for the Bourbons, and the yard-arm of Nelson's ship became Lady Hamilton's gallows.

Although Naples is Catholic, the hero would not give his victims even twenty-four hours for confession, but with coarse gibes strung them up and cast their bodies overboard. Ferdinand came out of his hiding-place, and wholesale executions proceeded with unbelievable horrors—Nelson acting as chief hangman of the most loathsome monarch of Europe.

Among the captives was Domenico Cirillo. The famous scientist was now sixty, and knowing little of politics, was anxious to return to his hospitals. As both Dr. Cirillo and Sir William Hamilton were Fellows of the Royal Society of England, the old professor naïvely addressed an appeal to the ambassador's wife. The reply came from Nelson himself. First he insulted Cirillo grossly, and then took his life. Linnæus praised Cirillo, but Nelson hanged him. In every age, certain women have played with destiny by controlling the dominant men of the period, but never has there been a more striking example of an evil spirit in a beautiful body than in the case of Lady Hamilton. To please her, Nelson became a common and vengeful criminal; to gain her smile, he turned the Bay of Naples into the sea of the dead; because of their adulterous union, thousands of the best citizens of Naples were mocked and murdered. Even to-day children are named after Horatio Nelson, yet not all the waters of the Nile in flood, nor all the waves that roar at Trafalgar, can erase that innocent blood. In an age more enlightened than ours, every stone of the Nelson Monument will be razed to the ground, and on its site will arise an expiatory plinth to Domenico Cirillo—and those who know the tale will add the inscription: Naturalist and savant, humanitarian and martyr, physician to the poor and pioneer of inoculation.

II

When Mary Wortley Montagu passed out of this world, venerable now and white-haired, a lively little fellow of about twelve was always willing to exhibit his collection of dormouse's nests—all found by himself among the bushes—but this did not mean that he was certain to be a great scientist, for childhood is naturally curious, and every boy who experiments in catching flies, or breaks an egg-shell to see why the chicken doesn't come out, does not develop into a Lamarck or a Purkinje. Some of them become politicians, and are averse to all investigation.

Youthful Edward Jenner had none of the eccentricities of genius. He did not muse, mope, or argue with his nurse in Greek to convince her that he was precocious. He was not like the babe Macaulay who smoothed his bib and said, "Mamma, industry is my bread, and attention my butter." On his second birthday he did not inquire what was the purpose of life, and there was nothing to distinguish him from the other lads of Gloucestershire.

When he grew older, he learnt the lure of apparel, and ornamented himself with a blue coat and yellow buttons, the sprucest buckskins in the market, well-polished jockey-boots whose silver spurs he often clanked together, a handsome whip that smacked the air with a whizzing sound, and when he removed his broad-brimmed hat he revealed his hair stylishly done up in a club.

He was fond of society, being a favorite in it. Not only was he a good-natured and animated companion, but he possessed those accomplishments which are immediate passports of admittance to the shrine of conviviality: he could perform on the violin and the flute, and when properly urged by the ladies he would warble songs that he had written himself. Some of his verses were really clever.

His biographer assures us that Jenner never played cards, and while this may be a fact—as he was the son of a clergyman—we must accept the statement with suspicion, for biographers have the bad habit of attempting to make their heroes too respectable. The more we learn of famous men, the more do we see that they did not scorn what is colloquially known as "having a good time." Gibbon was gay in Paris, and when Darwin was a student at Cambridge he sometimes drank too much. "I know," says the author of *Origin of Species,* "I ought to feel ashamed of days and evenings thus spent, but as some of my friends were very pleasant, and we were all in the highest spirits, I cannot help looking back to these times with much pleasure." The average freshman might quote the above words in explaining to his father why his acquaintance with the college curriculum was not more intimate.

As already mentioned, Jenner was the son of a clergyman, and his mother was a clergyman's daughter before she became a clergyman's wife; her brothers were clergymen, and almost all his sisters married clergymen, and nearly all their children became clergymen, but in spite of this alarming situation, Edward Jenner manifested an inclination for the natural sciences —perhaps his collections of nests and fossils meant something after all—and he was sent to Sodbury, near Bristol, to learn surgery and pharmacy under the preceptorship of Daniel Ludlow.

While Jenner was working for Ludlow, a country-girl came there for treatment. Smallpox was mentioned in her presence, to which she replied, "I cannot take that disease, for I have had cowpox." The young apprentice happened to be in the room at the time, and pricked up his ears with interest. He recalled that the farmers and dairy-maids of Gloucestershire had the same notion. The next day, while running an errand for his master, he found himself thinking on the topic.

That Jenner had the scientific spirit is evident from an incident which occurred long before the chemist of Heidelberg invented the Bunsen burner: a discussion arose whether the temperature of a candle is higher in the center of a flame or at a small distance from its apex. Instead of indulging in theory,

MARY WORTLEY MONTAGU

Jenner drew the candle towards him, and inserted his finger in the middle of the flame, keeping it there for some seconds. He then placed it a little above the flame, but was immediately compelled to withdraw it. He thus solved the problem in a manner that would have delighted John Hunter, whose everlasting query was, "Why not make the experiment?"

In 1770, being then in his twenty-first year, Jenner arrived in London, where he became the favorite pupil of the illustrious teacher to whom we have just referred. The following year Captain Cook returned from his first voyage of discovery, his ships loaded with specimens collected by Sir Joseph Banks. Hunter was asked to name someone who could arrange and classify this museum of natural history, and he recommended his pupil. With such skill did Jenner perform his work that he was asked to accompany the next expedition as naturalist.

What an opportunity for a youth of twenty-two: to sail around the world in the interests of science; to enter unknown waters and give names to unexplored territory; to gaze upon strange faces, and collect fossils in islands previously undisturbed by the European; to penetrate for the first time a virgin forest, and chase a wild animal over sands that never knew a human footprint. Such prospects have made older scientists sleepless with enthusiasm, but Edward Jenner would not go. He was neither adventuresome nor ambitious, he wished to return to the rural scenes of his childhood, and above all he was unwilling to be separated from his eldest brother. The phrase, "they loved each other like brothers," is often received with derision, but Edward Jenner and Stephen Jenner proved that brothers can love.

Jenner settled in Gloucestershire, in the shady vale of Berkeley, to prescribe tartar emetic to the neighboring farmers. But John Hunter did not permit him to lead the life of the ordinary village doctor. "I want," wrote Hunter in a series of letters, "a salmon that has just spawned; I will take a cock salmon when you please. . . . Let me have some bats; try some yourself, open a hole in the belly, and observe the heat there, and the fluidity of the blood, also see if you can catch the number of pulsations and the frequency of breathing in the bat. . . . I thank you for your experiments on the hedge-hog; but why do you ask me a question by way of solving it? I think your solution is just; but why think—why not try the experiment? . . . What do you think of examining eels? Their sexes have not yet been found out, nor their mode of propagation; it is a thing of consequence in Natural History. . . . Next spring I would have you make experiments upon the growth of vegetables, and if you have no objection, I will set you upon a set of experiments dealing with the heat of vegetables in the winter. If in any of these pursuits you discover any principle worthy the public, I will give it into the Royal Society for you. . . . I received your account of your experiments on the hedge-hog, also the dog-fish, for which I thank you. I have now received your account of the aneurismal vein with the cast, and I showed it to my pupils this evening with the description. I hope you will be able to procure the arm when the man dies. . . . If a good deal of that air of the hog's guts could be collected, see if a candle will burn in it as large as in common air. . . . What are you doing? how do hedge-hogs go on?" Jenner was fond of this research work, and on his own initiative started out to solve the problem why it is that the cuckoo lays its eggs in another bird's nest: his reflections on nature's nastiest creation are interesting.

But all the while he bore in mind the reputed prophylactic power of the cowpox, and listened to the gossip of cowherds as if he were an antiquarian collecting the folk-lore of a disappearing race. Year after year, with remarkable patience, he investigated every phase of the distemper. The disease in the cow was mild, and the disease in man was virulent, so Jenner thought it would be a great thing if cowpox could be transferred to the human subject for the purpose of modifying the terrible smallpox. One attack of smallpox usually exhausted the susceptibility of the constitution to a second attack—the same as scarlet fever or measles—and since, argued Jenner, the cowpox is only a benign form of smallpox, why not introduce the cowpox virus into the system of man and thereby save him from the malignant type?

To read text-books is easy—if they are written with a certain respect for grammar—but to do research work is to grapple inch by inch with the obscure, and battle step by step with the unknown. Jenner found his path beset with difficulties that would have turned aside any man who was not a genuine scientist. He found that cows were subject to a variety of eruptions on their teats, all of which were capable of producing sores on the hands of the milkers, but that only certain of these sores afforded the system protection against smallpox. The distinction of true cowpox from spurious cowpox, by explaining why cowpox sometimes failed to prevent smallpox, was a decided step forward. But when further investigation revealed to Jenner that some individuals who had been infected with what he himself termed true cowpox, later caught smallpox, he was in that uncomfortable condition of mind which only John Hunter enjoyed: puzzled. Tackling the matter again, he was rewarded by the important discovery that the virus of true cowpox is subject to deterioration, and that only during a certain stage does it possess the virtue of protecting the human system against the invasion of smallpox.

To save the face of mankind from the papule, vesicle, pustule and crust, became the engrossing purpose of Edward Jenner's life. At a medical society to which he belonged he persisted in speaking of the protective power of the cowpox so continually that the other members felt bored and threatened him with expulsion.

His confrères were much better pleased with him when they found him exhibiting interest in a subject which was beyond doubt: a maiden. Some of his friends recalled and quoted a proverb current since mediæval times: "From smallpox and love but few remain free." Thereupon—although it was not yet written—Jenner illustrated that chapter of Darwin's which begins, "Blushing is the most peculiar and the most human of all expressions."

Of course, in such affairs, friends are always more certain of the outcome than the lover himself. Jenner's friends, for instance, were sure he was going to marry, but the lady in the case was sure he wasn't, for when he proposed, she answered, "No, sir, but thank you just the same." The world no longer remembers her, for by refusing to become Jenner's wife she lost her opportunity of having her name in the *Encyclopædia Britannica.*

The matter has never been satisfactorily explained, but it seems women do not take kindly to unusual men—with the exception of Byron. Every bar-room brawler relates his conquests of femininity by the hour, and the clerk, the book-keeper, and the mechanic—if only he have a starched dicky and a spangled vest wherewith to shine—exhibits trophies that Herbert Spencer could never have obtained. A nobody marries Beatrice and demands his slippers, and a nonentity becomes the lord of Laura and grumbles about his food, while a Dante and a Petrarch must worship these ladies from afar. It took Madame Hanska many years to decide whether she was willing to marry Balzac, and John Keats could get no satisfaction from Fanny Brawne, while any traveling salesman whose tie matches his socks, could have carried off the girl in three weeks. Goffredo Mameli's love was not returned, and Miss Aloysia Weber said "Never!" to Mozart—and meant it.

Montaigne's famous "pillow of doubt" was soft indeed when compared to the pillow of unreturned love on which Edward Jenner now lay. "Never mind," wrote John Hunter, "let her go. I shall employ you with hedge-hogs." It was fortunate for Hunter that he was Hunter, otherwise he would have received a wrathful reply, for to a youth in a sentimental mood nothing is so distasteful as humor. Jenner was really disappointed, and as is natural at such junctures, contemplated suicide, and as is also natural, did not commit it. But many years were to pass before he forgot his first flame, for unlike the average male, Jenner was not an expert in the art of transferring his affections. Neither could he draw any relief from the popular adage, "There is as good fish in the sea as ever was caught."

Yet Father Time, a greater physician than even Hippocrates, gradually healed his wounds, and precisely when his friends were convinced that he was going to remain a bachelor, Jenner again felt the glorious spring-time stir within him. On this propitious occasion his feelings were reciprocated, and at the proper time a happy Yes faltered from the lips of Miss Catherine Kingscote, who is described as possessing elegant manners and other virtues. How Jenner would have fared with his first lady-love we cannot say, but we know that his long married life with Catherine was ideal from first to last, which proves that a man should never commit suicide when he is rejected only once.

Along the road that runs between Gloucester and Bristol, two companions were riding, engaged in conversation. The earnestness with which the elder spoke of exterminating smallpox revealed his identity. "Gardner," said Jenner, "I have entrusted a most important matter to you, which I firmly believe will prove of essential benefit to the human race. I know you, and should not wish what I have stated to be brought into conversation; for should anything untoward turn up in my experiments, I should be made, particularly by my medical brethren, the subject of ridicule—for I am the mark they all shoot at."

As the solution of the great problem grew nearer and nearer, the inner life of Jenner became intense. He rambled through the meadows, near the ancient ruined castle of Berkeley, silent and alone, but the frequent flashing of his eye disclosed the fire that was burning within him, and the involuntary raising of his hand, as if he stood in the presence of something sacred, indicated that he was overpowered with emotion.

It is not difficult to understand his excitement if we invoke the ghost of smallpox that terrorized our forefathers. For centuries smallpox was the vastest horror that plagued the human race. At the tables of man no other evil and unwelcome guest was so familiar and so dreaded. During that long period no mother counted her children till all had passed through smallpox. In those days the young men sighed, "Oh, for a mistress who is not pock-marked."

From its ravages no one was safe. It granted no favor to the old, it smote the middle-aged, it struck down the young, it scarred the babe in the womb. None were so lowly as to be passed by without notice, none so powerful as to enjoy immunity. Not only did it stalk through the narrow alley, but it walked abroad on the boulevard. It lay on the toiler's cot of straw, and parted the purple curtains of the emperor's bedstead. Long before socialism was heard of, smallpox proclaimed, "Special privileges to none."

Elfrida, Alfred's daughter, the wife of Baldwin the Bald, was attacked by smallpox, and her grandson succumbed to the malady. It touched the fifteenth Louis of France, and the king rolled from his throne to the grave. It maimed and crippled William the Third of England, and ended the life of his young and beautiful Queen. On the same day it ordered coffins for Mary in the almshouse and Mary in the palace—pauper-woman and royal-lady equally speckled with pock-holes.

If Iwan Bloch is correct in assuming that syphilis had its origin in America and was introduced into Europe by the crew of Columbus, we may ask if it is not unfortunate that America was ever discovered. The licentiousness of imperial Rome in the fifth century was followed by the invasions of Huns and Vandals, but the libertinism of southern Europe in the fifteenth century was followed by the worse invasions of chancres and tertiary lesions. But certainly the pale-faces had no ground for complaint, for though the Indian women may have surprised the Spaniards with a new disease, the gallant dons squared up matters by bringing to America the scourge of smallpox.

When smallpox conquered America, the empire of the monarch of diseases was universal. No corner of the earth was now safe from the pock-mark. Everywhere it excited a common terror that made the whole world kin. With swift feet that traveled from household to household, with many-fingered hands that clutched the passer-by, with its impalpable poison carried by the atmosphere, and blown abroad by the winds, smallpox seemed like an eternal biblical curse.

Falling upon the natives of Mexico, it destroyed six million inhabitants with the same fury that it had decimated China in the pre-Christian era. The naked savage squatting on the equator, and the fur-clad Eskimo of the arctic circle, were equally apprehensive of its approach. It entered uninvited the wigwams that dotted our western prairies, and made itself at home among the straw-thatched huts of the African. It thinned the population of Ceylon, and in many districts of Iceland there were not sufficient survivors to bury the dead.

In the course of ages, the human race accumulated such fear of the eruptive fever that when the epidemic swooped upon the crowded communities of civilization there were times when sick infants cried in vain for mothers who had fled. When its pimpled visage appeared in the untamed forest an Indian father would call his family together, speak to them of the evil spirit which was torturing the tribes, and pointing to the dehumanized features of those already attacked, would exhort his children to escape a similar fate by falling upon their own daggers, promising them if they lacked the courage that he himself as a last proof of his devotion would do the deed of mercy, and at once follow them to the happier land.

"Smallpox," wrote Macaulay, in the fourth volume of his *History of England,* "was then the most terrible of all the ministers of death. The havoc of the plague was far more rapid: but the plague visited our shores only once or twice within living memory; and the smallpox was always present, filling the churchyards with corpses, tormenting with constant fears all whom it had not yet stricken, leaving on those whose lives it spared the hideous traces of its power, turning the babe into a changeling at which the mother shuddered, and making the eyes and cheeks of the betrothed maiden objects of horror to the lover."

But it is unnecessary to exhaust our vocabulary, or to quote eminent historians, when the plain Arabic numerals are more eloquent. In preceding centuries, about 10 per cent. of all deaths were attributable to smallpox. In the single year 1796, the smallpox carried off 30,000 of Prussia's inhabitants, and about the same number were annually destroyed in France. Iceland was invaded in 1707 by smallpox which caused in that one year the loss of 18,000 out of a population of 50,000. In regions as widely separated as Brazil and Kamschatka whole races of men became extinct through the fearful fatality of this disease. Sir Alexander Crichton calculated that annually every seventh child born in Russia died of smallpox. Bernoulli figured that every twenty-five years it deprived not fewer than 15,000,000 human beings of life. These numbers correspond to the estimation that has been made that in the eighteenth century alone smallpox killed at least 60,000,000 men, women, and children. Death statistics, however, tell only a portion of the damage done, for millions of the so-called survivors, weakened, crippled, sightless, became subject to half the pathologic terms found in a medical dictionary.

In those stricken days, if a messenger had come from heaven, and standing on earth's highest hill had clarioned to all mortals, "From the long roll of human evils I shall remove one disease: which shall it be?"—one universal voice would have ascended in answer, the desire of kings blending with the prayer of peasants, the cultured accents of the scholar mingling with the cry of the man of the streets: "Smallpox!"

And now a humble village doctor expected to conquer this monster by a bit of virus on the point of an ivory lancet.

A dairy-maid named Sarah Nelmes, who had been pricked by a thorn, and become infected with cowpox while milking her master's kine, was his medium. On the fourteenth of May,

EDUARD IENNER. M.D.

Endeker der Schuzblattern.

1796, Jenner took matter from her hand and inserted it by two superficial incisions into the arm of James Phipps, a healthy boy of eight. This was the first vaccination. On the first of the following July virulent smallpox matter that would have killed any unprotected lad in the world was introduced into this arm, but without the slightest effect, for Phipps had been vaccinated! This was the crucial experiment.

The vaccine virus could be passed from one human being to another; it was safe in itself, and endangered no one by contagion; the experimentation of twenty-five years was over; the problems were solved and ready for publication; a gate of death was closing—smallpox would become a disease of the past. That day the gossips of Berkeley who lingered by the village pump greeted Jenner as he passed, but did not know that their fellow-townsman had made the world a safer habitation for the race of man.

The printer now became an important personage, and when all matters were arranged, a quarto of about seventy pages appeared, *An Inquiry into the Causes and Effects of Variolæ Vaccinæ.* This was the name which Jenner had given to the cowpox to indicate that he regarded it merely a variety of the variola, modified by passing through the bovine species. The quarto contained an engraving of the hand of Sarah Nelmes, showing the position and development of the pustules. It is a rather delicate hand, with tapering feminine fingers. Were it not for the pustulous sores on it, a poet might write a sonnet to this hand—the hand that helped to halt a plague.

The first enthusiast in the cause of vaccination seems to have been the surgeon Henry Cline, who urged Jenner to come to London immediately, painting in glowing colors the future that awaited him. But Jenner was now fifty years of age, and peaceful Berkeley was good enough for him. Prospects of gold and glory could not lure him to the Strand. He wrote to Cline that even in the morning of his days he had sought the lowly and sequestered paths of life, the valley and not the mountain, and now the evening was fast approaching, and he would not hold himself up as an object for fortune and for fame.

But when his nephew George, who was in London at the time, informed him that a person named Pearson was pushing himself forward as the chief agent of vaccination, but knew so little of the whole subject that he distributed virus contaminated with smallpox, Jenner was aroused. When he further learnt that Dr. Pearson had secretly organized an institution for vaccine inoculation, and when that enterprising gentleman had the effrontery to offer him the position of extracorresponding physician, Jenner said, "Catherine, where is that valise of mine?"

Jenner hurried to London, and induced Lord Egremont and the Duke of York to withdraw their patronage from Pearson's institution. The modern Icarus found he had soared too near the sun, for his waxen wings melted, and he was drowned in the sea of obloquy.

It was inevitable that vaccination should arouse antagonism, both from the profession and the laity. Of course one clergyman declared that the practice was as old as the Bible, and the reason Job had so many boils was because the Devil had vaccinated him, while another preacher solemnly assured his parishioners that God sent smallpox into the world because Adam and his wife liked pippins. Dr. Moseley claimed that communication with beasts might corrupt the mind and excite incongruous passions; while William Rowley, who seemed to believe in clinical demonstrations, exhibited a boy with a swollen face at one of his lectures, and explained the case as follows: "On this cheek you plainly perceive a protuberance arising like a sprouting horn; another corresponding one will shortly spring up on the other side; for this boy is gradually losing human lineaments and his countenance is transmuting into the visage of a cow."

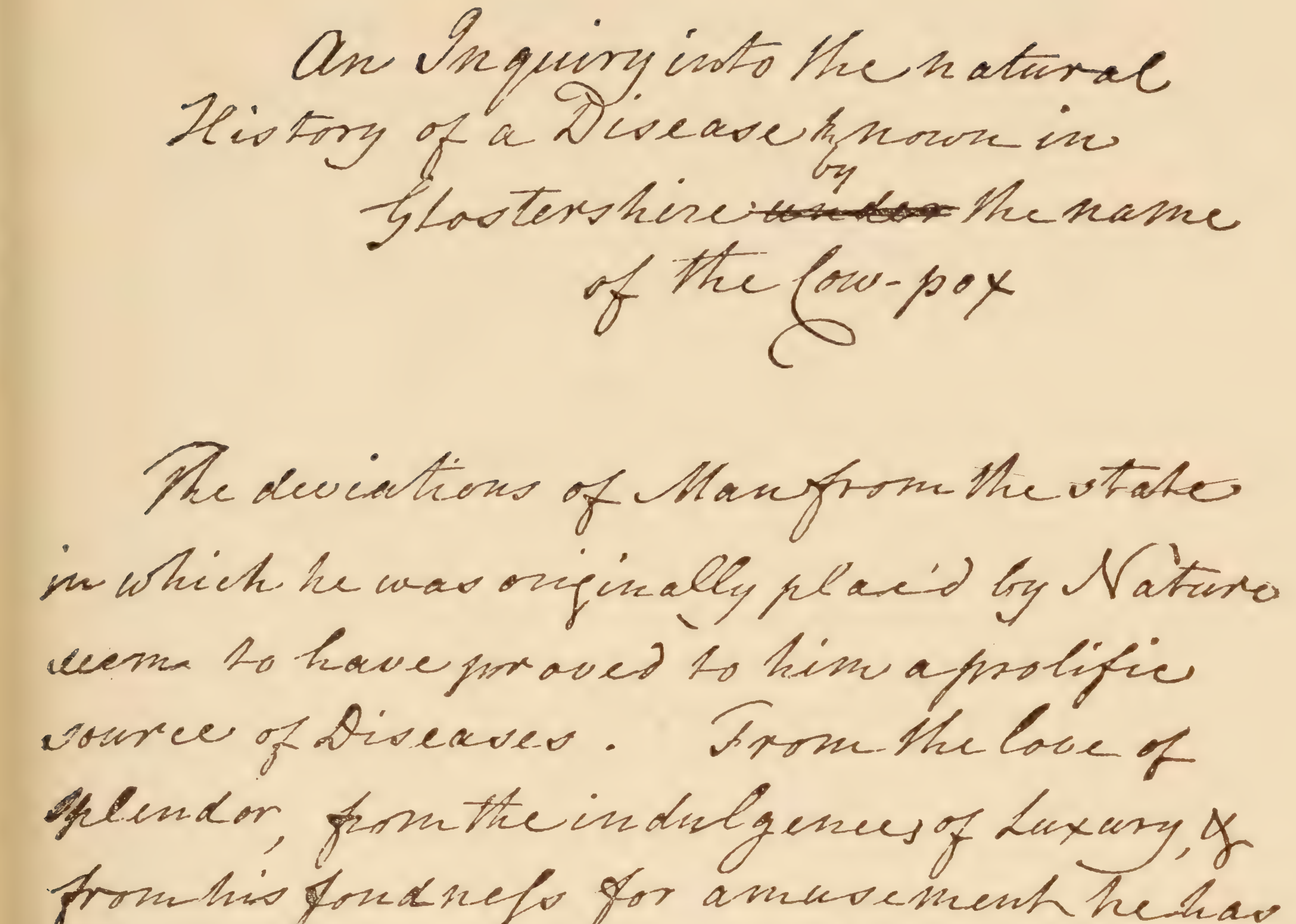
But anyone conversant with the History of Medicine, who contemplates for a moment the reception of other medical discoveries, is astonished, not at the opposition which vaccination engendered, but that the opposition was so slight and cursory. Smallpox was so terrible, that vaccination was given a trial, and in hamlet and metropolis its beneficial effects were immediate. The ivory scarifier was a magic wand which checked the approach of the epidemic. The medical dream of a Diseaseless Future moved one notch nearer its realization.

To say that vaccination spread like a new gospel would not express the situation, for even the most prevalent religions are limited by longitude. But vaccination overrode all boundaries and mixed with all men. A British ship sailed from Portsmouth to Gibraltar, and vaccinated the soldiers of the garrison. Dr. Marshall vaccinated his own children and then introduced the practice into Naples and Palermo, where the superstitious inhabitants declared it "a blessing sent from Heaven, though discovered by one heretic and practised by another." John Walker vaccinated Abercrombie's army in Egypt; the three children of Helenus Scott were the first to be vaccinated in India, and thereafter the Doctor vaccinated thousands: the Hindoos, on account of their veneration for the cow, considered Vaccina a new divinity. Dr. de Carro, who had succeeded in importing the virus into Bombay, likewise, introduced Jennerian inoculation into Vienna, Lombardy, and Poland. Marcet transmitted the vaccine to Copenhagen, and smallpox disappeared from Denmark and Sweden. Princess Louisa of Prussia was inoculated, and an Inoculation Institute was established in Berlin. Count de Salm offered a reward to the physician who vaccinated the largest number in Moravia and Bohemia. Lord Elgin, ambassador to the Porte, had his infant son vaccinated: the gift which England had received from Turkey, it returned a thousand-fold. The practice entered the Seraglio, and the Grand Seignior, who had suffered much from smallpox, sighed that the discovery had not been made in his early days. Over the Bosphorus, and across sandy deserts, the vaccine was conveyed, traveling along the banks of the Tigris to spread its blessings to Persia. Greek, Armenian and Parsee brought their children to receive the virus. In the Peloponnesus and in Poonah the name of Jenner was lauded to the skies. The history of the discovery was published in Bengalese and in Sanskrit. Ceylon had been ravaged frightfully by smallpox, and in one district and in one month Thomas Cristie vaccinated two thousand natives. Dr. Grahl spread it through Siberia, and no wall could prevent the Chinese from coming in swarms with arms bared for the vaccine. The Spanish government, usually so backward, fitted out an expedition which carried vaccine around the globe. Benjamin Waterhouse introduced vaccination in the United States, and sent a sample of the virus to the brainiest President that ever sat in the White House: Thomas Jefferson with his own hand vaccinated over a hundred of his fellow-citizens.

Then occurred something unique and unparalleled in the annals of medicine. In Upper Canada, the grateful Indians, the Five Nations, the Mohawks, the Onondagas, the Senecas, the Oneidas, the Cayugas, gathered together to pay tribute to Jenner:

> Brother! Our Father has delivered to us the book you sent to instruct us how to use the discovery which the Great Spirit made to you, whereby the smallpox, that fatal enemy of our tribes, may be driven from the earth. We have deposited your book in the hands of the man of skill whom our great Father employs to attend us when sick or wounded. We shall not fail to teach our children to speak the name of Jenner; and to thank the Great Spirit for bestowing upon him so much wisdom and so much benevolence. We send with this a belt and string of wampum, in token of our acceptance of your precious gift; and we beseech the Great Spirit to take care of you in this world and in the land of Spirits.

Crowned potentates, from the King of Spain and the Emperor of France down to the Queen of Etruria and the Hospodar of Moldavia, were desirous of honoring Edward Jenner. A certificate signed by Jenner, declaring that the bearer was abroad merely for his health, had the authority of a passport. The King of England gave him permission to dedicate the



An Inquiry into the natural
History of a Disease known in
Glostershire ~~under~~ by the name
of the Cow-pox

The deviations of Man from the state in which he was originally plac'd by Nature seem to have proved to him a prolific source of Diseases. From the love of Splendor, from the indulgences of Luxury, & from his fondness for amusement, he has familiariz'd himself with a great number of animals ~~that~~ which may not originally have been intended for his associates. The Wolf, disarm'd of ~~its~~ ferocity, is now pillow'd in the Lady's lap.* The Cat, the little Tyger of

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* The late Mr John Hunter proved by experiments that the Dog is the Wolf in a degenerated state.

FIRST PAGE OF JENNER'S MANUSCRIPT
of An Inquiry into the Causes and Effects of the Variolæ Vaccinæ.

second edition of his *Inquiry* to him, but in Jenner's flattering description of the monarch as "the Father of his People," and in his reference to his "paternal care for the dearest interest of humanity," we would hardly recognize George III. The Empress of Russia wrote a personal letter to Jenner and sent him a ring studded with diamonds. She ordered that the first child vaccinated in Russia be named Vaccinoff, and be educated at the expense of the State. Later, Jenner met the Czar himself, and related with some gusto that he was the first person who ever dared contradict the autocrat. During the war between England and France, Jenner petitioned for the release of some British prisoners; Napoleon refused the request, and Josephine mentioned that it was Jenner who wished it. "Ah," said Napoleon, "we can refuse nothing to that man." Jenner was introduced to so many members of the aristocracy, that he must have grown tired of saying Your Grace and Your Royal Highness, but when a Countess brought him a hookah, no doubt he promised to smoke it all his life.

The fame which was Jenner's during the latter period of his life, so different from the obscurity of his first fifty years, never upset him. He remained simple and unaffected to the last. He could not learn to love the busy, crowded, gloomy, commercial streets of London, and he was never so happy as when he could steal away to Berkeley by the side of Mrs. Jenner. Only one woman in the world existed for Jenner, and she was his wife.

In the days when temples were erected to Jenner, when religious processions marched shouting his name, when men begged for a pattern of his coat that they might wear the same garb on his birthday, Jenner heard that his oldest son was ill, and immediately he left for home. Important letters from London failed to move him. "In this unfortunate situation," he wrote, "I should be unworthy of the name of father were I to stir from my children. Indeed, nothing would make me, not even a royal mandate, unless accompanied by a troop of horse."

He ended as he began—the best type of the country doctor. On many wintry nights, and over many a stormy road, he urged his horse to the huts of the poor—often without a fee. Contact with royalty had failed to contaminate him. Edward Jenner was a man. When he was molded, the potter omitted the most common of all ingredients—sycophancy.

That Jenner should continually have conducted himself with such simplicity and dignity, speaks well for the natural grandeur of his character, for his was not an intellect of the first order. He was a skilled observer, a successful experimentalist, but no thinker. He had not a tithe of the mental reach of the man who first used the term "agnostic," and in all phases of rational and abstract philosophy he was a babe. No problems of the origin of our species, or of its ultimate destiny, ever perplexed his mind. He believed an answer to all such questions could be found in the writings of Moses. Jenner was born in the same year that gave birth to Laplace and Goethe, and when we consider how the Frenchman speculated in the science of the skies, constructing a system of the universe without the hypothesis of God, and when we recall the German's endless intellectual sweep, formulating in a manner even the doctrine of Evolution, Jenner's limitations become apparent.

But in view of Jenner's practical work it would be as unjust to dwell upon his theoretical shortcomings as it would be to emphasize Alfred Russel Wallace's fall from Science to Spiritualism. Men far greater than Jenner have done far less for human happiness than he. Jenner made the most dreaded of maladies the least feared. Mankind is now more afraid of a cold in the head than of smallpox. Even in the poorest sections of our cities we would have to walk long to come across a pitted servant-girl. Measles bends over every cradle; the bacillus that Koch saw in 1881 is as much a menace to-day as it was twenty-five centuries ago, when Hippocrates called consumption the most dangerous disease; every autumn typhoid relentlessly claims its victims; on many doors the Board of Health tacks up the sign "Scarlet Fever"; and the swift and sudden onslaught of pneumonia carries desolation in its wide trail; but so effectual has been Jenner's discovery that many active physicians of the present generation have never seen a single case of smallpox. The invalid once so common—bloated and puffy with pustules; his skin covered with crusts that fell off only to reveal scars that were permanent; itching, vomiting, delirious; vile to the smell and hideous to the sight; exhausted, feverish, trying to pick the bedclothes with flexed and stiffened fingers; with boils and abscesses in uncomfortable places, hair coming out, and the mouth held half open because of the edema of the buccal mucous membranes; staring apathetically through a swollen and yellowish mask, with ulcers where eyes should be—this exemplification of agony and wretchedness has become almost obsolete because Edward Jenner lived and worked.

Modern sanitation has accomplished wonders—a thousand victories of medical science are summed up in that one word—but hygiene cannot account for the practical extermination of the shotty papule. Smallpox never feared soap and water, and was as apt to infect a bathing beauty as Simeon Stylites. Only one agent can keep the smallpox in check, and that is vaccination. And vaccination has done it so well that we have forgotten what smallpox means, and therefore we sit back securely and form anti-vaccination societies. But let the vaccine virus be withheld from our bodies, and before many a moon waxes and wanes, the pock-marked face will greet us on every street-corner.

After the decease of his wife, Jenner retired almost completely from the world. Alone, at sunset, he would climb Barrow Hill and watch the Severn at its highest tide. From the summit he could see the forest of Dean, and afar off glistened the Bristol Channel, where sometimes a ship glided past in the twilight. Here he would linger till the orchards faded from view, and the oaks grew dim and ghostly, and the cliff which rose from the river-side could be seen no more.

His life too was sinking below the hills, soon to be enshrouded in darkness. He died where an intellectual man should die—in his library. The village which gave him birth received his illustrious ashes. When his wornout body was laid at rest, it would not be surprising if some humble woman, whose child he had saved from smallpox, imagined that Edward Jenner had gone to heaven—to vaccinate the angels.

(1731–1810)

HENRY CAVENDISH

Cavendish gave me once some bits of platinum for my experiments, and came to see my results on the decomposition of the alkalis, and seemed to take an interest in them; but he encouraged no intimacy with any one, and received nobody at his own house. . . . He was acute, sagacious, and profound, and, I think, the most accomplished British philosopher of his time.

Sir Humphry Davy.

XII

HENRY CAVENDISH

I defy any biographer to write an interesting sketch of Henry Cavendish. Some careers lack picturesque irregularities, but his was destitute of a single episode. He never sowed wild oats in the fields of life—only tame sweetpeas in the retired gardens of science. There was no dash of recklessness in his make-up. He passed his youth without committing an indiscretion. The wings of enthusiasm did not grow on his shoulders.

Even in the trivial affairs of daily existence, Cavendish had a mania for method. At the Royal Society he always hung his hat on the same peg; he would never ride in his carriage without measuring the miles; every morning not only were his boots found in a special position, but the point of his walking-stick was always standing in a particular way and in the same boot; at his mansion in Dean Street he fitted up a valuable scientific library which was at the disposal of all research-workers, and Cavendish himself would never take a book from it without signing a formal receipt; for dinner he had invariably a leg of mutton: on an unparalleled occasion, when some scientists were to dine with him, his housekeeper asked what was to be had for dinner. "A leg of mutton," said Cavendish. "Sir, that will not be enough for five." "Then get two legs," responded the charming host.

Cavendish could have given Amos Bronson Alcott lessons in the simple life; he was as frugal as a pastoral bard, and no sodium urate enlarged his hallux; in truth, he had not those disorders that require the services of a medicus, nor was his existence ever enlivened by a law-suit, but his pathologic fear of the primate mammal was so pronounced, that anthropophobia should be popularly known as Cavendish's Disease.

To meet a young lady one night, and to have his arm around her waist the next night—this was a pleasing miracle which he never accomplished. Cavendish did not even desire the sex. He was the model misogynist. It is admitted he was born of a woman, but she died when he was two years of age, and he never had a sister or a female acquaintance.

Cavendish, like Erasmus, was raised by his father, and like that wise monk who poked fun at monasteries and praised only Folly, he might have written: "Two parents are the rule; no parents the exception; a mother but no father is not uncommon; but I had a father and never had a mother. I was nursed by a man, and educated by monks, all of which shows that women are more or less of a superfluity in creation. God himself is man. He had one son, but no daughters. The cherubim are boys. All of the angels are masculine, and so far as Holy Writ informs, there are no women in heaven."

But Erasmus wrote this letter to a lady, a dissipation in which Cavendish did not indulge. Moreover, Erasmus had a sense of humor, which Cavendish was minus. Nature must have been confused when she molded a sixteenth century monk more sociable than a modern British chemist. The critical reader will here discern that it was not this Cavendish who won fame as an authority on whist.

Such was this man's aversion to women, that happening to meet one of his maid servants on the steps, with a broom and pail, he ordered a back staircase to be built. At a certain hour of the day he left a note on the hall-table for his housekeeper to take unobserved, for any female domestic whom he saw, he dismissed.

He did not feel a tide of passion surge within him in the spring-time. He never succumbed to calf-love or the maturer variety. He formed an exception to Alice Lloyd's declaration, "We all want something to cuddle." He does not remind us, unless by the law of antithesis, of the young French author who confessed to Marie Bashkirtseff, "Women are my passion."

In short, we recall no other son of Adam who lived so sexless a life as Cavendish. It does no good to name professed celibates, for secret meetings between monks and nuns are not always fairy-tales, and Popes had the habit of being fathers not only in a spiritual sense. August Strindberg—a more violent woman-hater than Schopenhauer himself—has been thrice married. Sir Isaac Newton, who was so engrossed in differential calculus that he had no carnal knowledge, might have become a husband if his mind hadn't wandered to the realm of theory at the moment he was expected to woo. Amiel, the sad eremite of modern philosophy, yearned for wedlock. Herbert Spencer probably would have proposed to George Eliot if she hadn't run off with the homeliest man in London. Even Carlyle and Ruskin, impotent though they were, took wives unto themselves, but if Cavendish had been shown a bodice, he might have analyzed its constituents, but would not have understood its functions.

Cavendish's relation to males was scarcely more intimate. It is fortunate circumstances never compelled him to perform that little conventionality called "making a living." There is nothing like travel to make a man reminiscent, and during 1785 and three other years, Cavendish journeyed through the greater part of the island for geological and meteorological purposes. In his written record, not a single personal incident is related: only the heights that the barometer determined, and the strata that the hammer explored. Of the people he met by the way, of the wild scenery of Wales, there is no account. At Birmingham, Watt himself explained to Cavendish his improvements of the steam-engine. In his MS. Journal, Cavendish wrote, "Mr. Watt thinks to have ascertained by experiment, that the less heat water is converted into steam with, the more latent heat it requires, to assume the elastic form," but how the great engineer looked, or how he spoke, Cavendish does not say.

Nor was Cavendish concerned with political affairs. He lived in the days of 1776, when John Hancock wrote his signature large enough for England's king to read without his spectacles, but Cavendish did not bother a rush whether the thirteen colonies along the Atlantic coast were ruled by George III or by George Washington.

The Ancient Mariner was alone on a wide sea; but Cavendish was alone in London. He had no friends, and rarely met a relative: his chief heir came to him but once a year and seldom stayed half an hour. No voice called him Harry. There are few lips which at some time or other have not spoken the familiar phrase, "I love you," but it is doubtful if Cavendish ever said as much to anyone as, "I'm glad to see you."

Had Cavendish not dined at the Royal Society, or attended the conversaziones of Sir Joseph Banks, he would have been a myth. Saint Catherine vowed not to open her mouth for nine years, but Cavendish uttered fewer words in the course of his life than any human being on record, except those who are born dumb. In truth, the tongue to him was an unnecessary organ, even as to the Trappist whose vow includes perpetual silence.

Because a man is shy and solitary does not imply he is a misanthrope. A certain type of recluse is often intensely eager for sympathy and companionship. But they are sensitive souls, afraid of being misunderstood by grosser grain. Their reserve is a mask which they wear, and put on like furs in December—for protection against the cold. These hermits come out of retirement when the right person appears, and they then exhibit a depth of feeling of which others deemed them incapable. The bashful Hawthorne, for example, found such a person in Sophia Peabody, for it is said that woman by virtue of her intuitive instinct is especially fitted to penetrate the barrier of reticence, and view what lies beneath the surface of apparent indifference. Yet it is extremely improbable that anything of the sort could ever have occurred to the bizarre chemist under consideration. Cavendish really seems to have been an iceberg in breeches which no warmth could melt. If a man is a social animal, then Cavendish did not belong to the *genus homo*.

Amid the acclamation of the Romans, Terence exclaimed, "Nothing that is human is alien to me," but Cavendish reversed this maxim. He would not have been a member of Walt Whitman's Institution of the Dear Love of Comrades. He could not have appreciated Richard Burton's sentiment:

> High thoughts and noble in all lands
> Help me. My soul is fed by such;
> But ah, the touch of lips and hands,
> The human touch!
> Warm, vital, close, life's symbols dear,
> These need I most, and now and here.

We who grieve at the parting friend, and await his coming with joy, we who are met at the threshold of home, when the work of the day is over, with words of welcome, may shudder at the loneliness of Cavendish's life, and wonder if sometimes in the long night, as he walked through empty rooms, encountering nothing more cheerful than a graduated jar or a metallic eudiometer, there did not vaguely gnaw at his heart the desire to see outlined against the smoldering fireside, a human form. On second reflection the thought is a vain one, for if Cavendish wished such society he could have called up his female servants and treated them to wine, as Ibsen's Chamberlain Alving used to do, but there is more blasphemy in this conception than in Father McGlynn's idea of the Pope walking down Broadway with a plug hat on his head and a good cigar in his mouth.

Infrequently as Cavendish showed himself to his fellowmen, he sometimes underwent terrifying experiences in their company which must have caused him to vow to eschew even the dinners of the Royal Society and the soirées of Sir Joseph.

One evening, while the Fellows of the Royal Society were at supper, a pretty face watched them from an upper window on the opposite side of the street. Suddenly a learned Fellow lost interest in Lavoisier's views on combustion, and approached nearer the peeping beauty. One by one the philosophers left the table and concentrated around the window, thus proving Edward Clodd's contention, "Emotionally, we are hundreds of thousands of years old; rationally, we are embryos." Cavendish naturally thought the F.R.S.'s were studying the moon, but he mistook the planet. When he himself came to the spot and saw what his colleagues were observing, he turned away in the deepest disgust, audibly grunting his disapproval, for he was not a poet and did not believe that astronomy could be studied in a lady's starry eyes.

On the occasion of a gathering at Sir Joseph Banks', Ingenhousz formally introduced a foreign friend to Cavendish, explaining how anxious he was to meet such a profound and celebrated thinker. Dr. Ingenhousz's friend then assured Cavendish that he had come all the way from Austria principally to see and speak with one of the greatest ornaments of the age. As far as conversing with Cavendish went, the countryman of Marcus Plenciz might have remained in the Tyrol, for Cavendish answered never a word. The unhappy object of admiration had seen what was to him the horror of horrors—a strange face. Stricken with anthropophobia he stood there, with eyes cast down, in an agony of embarrassment, till he saw an opening in the crowd and darted away in a manner that recalled Newton's first law of motion: "A body in motion moves uniformly in a straight line unless acted upon by some outside force."

A Fellow of the Royal Society informed Charles Tomlinson, who was collecting material for George Wilson's *Life of Cavendish,* "I have myself seen Cavendish stand a long time on the landing, evidently wanting courage to open the door and face the people assembled, nor would he open the door until he heard someone coming up the stairs, and then he was forced to enter."

Then he came slouching along, uncanny in his awkwardness, with one hand behind his back, looking neither to right nor left, shuffling quickly and yet with hesitation, uttering a shrill cry if watched; the oddest figure of them all, dressing in old-fashioned gear: cocked hat, high coat collar, frilled shirt-waist, faded violet clothes, knocker-tailed periwig.

When some unusual occasion caused him to make use of his vocal chords, his voice was found to be squeaky, like a pulley that has not been recently used. The new Fellows found it expedient to follow Wollaston's advice, "The best way to talk to Cavendish is never to look at him, but to talk as if it were into vacancy, and then it is not unlikely but you may set him going."

Kerseboom painted Boyle, Fuseli painted Priestley, Faulkner painted Dalton, Sandberg painted Berzelius, Lawrence painted Davy, but no brother of the tribe of Joshua Reynolds could induce Cavendish to enter his studio.

Cavendish never imagined that his lineaments would descend to posterity, but an adventurous artist named Alexander, managed at a scientific meeting to sketch him surreptitiously, and the drawing is now preserved in the print room of the British Museum, for all the world to gaze upon.

But not even his suburban villa at Clapham Common—where grew a large tree which he ascended for his electrical and astronomical studies—was always safe from the intrusion of outsiders. Indeed, one day Cavendish was frightened to hear the voice of his servant, "Sir, there is a person below who wants to speak to you."

"Who is he? Who is he? What does he want with me?"

"He says he is your banker and must speak to you."

"Send him up. Send him up. . . . What you come here for? What do you want with me?"

"Sir," replied the borrower and lender of currency, "I thought it proper to wait upon you, as we have a very large balance in hand of yours, and wish for your orders respecting it."

"If it is any trouble to you, I will take it out of your hands. Do not come here to plague me."

"Not in the least trouble to us, Sir, not in the least; but we thought you might like some of it invested."

"Well! Well! What do you want to do?"

"Perhaps you would like half of it, say, forty thousand pounds, invested."

"Do so! Do so! and don't come here to trouble me, or I will remove it."

This ungracious man, who never had more than one suit of clothes at a time, was not a country bumpkin raised in a village. He was a lord and a millionaire, the most high-born chemist that Britain has produced. Heredity forgot, however, that one of his forefathers was Thomas Cavendish, the daring freebooter who circumnavigated the globe, burning and robbing Spanish ships on the watery way, and came sailing home with a crew clothed in silk, sails of damask, and a topmast covered with a cloth of gold. The house of Cavendish had long been illustrious: when a Cavendish died his corpse was met at the entrance of the town by the mayor and thirty burgesses in mourning. Henry Cavendish was the grandson of a duke by both parents, and the nephew and the cousin of one. He traced his descent back to a Norman family famous in the days of William the Conqueror, and his ancestors were connected by intermarriage not only with high aristocracy, but with the royal families of England and Scotland. But certainly our Cavendish had no interest in his Norman pedigree; it is bad enough that Lord Byron did. Cavendish kept no coat-of-arms, but he adopted this motto: "Let me alone."

We frequently observe that a human being who separates himself, or is cut off from his fellow-creatures, seeks solace in the healing powers of nature.

There is a pleasure in the pathless woods,
There is a rapture on the lonely shore,
There is society where none intrudes,
By the deep sea, and music in its roar.

The most ungregarious of American authors, who said he would rather sit on a pumpkin and have it all to himself than be crowded on a velvet cushion, lived alone in the woods, for he was in love with a beautiful pond. When the brilliant and broken outcast of British literature languished in cell 3.3, he did not think on his release to find a home among the haunts of men, but wrote from the depths, "Society will have no place for me, has none to offer, but Nature, whose sweet rains fall on unjust and just alike, will have clefts in the rocks where I may hide, and secret valleys in whose silence I may weep undisturbed. She will hang the night with stars so that I may walk abroad in the darkness without stumbling, and send the wind over my footprints so that none may track me to my hurt: she will cleanse me in great waters, and with bitter herbs make me whole."

But Cavendish was as indifferent to nature as to man. He could not declaim with Manfred:

> I linger yet with Nature, for the night
> Hath been to me a more familiar face
> Than that of man; and in her starry shade
> Of dim and solitary loveliness,
> I learn'd the language of another world.

Cavendish never slept under the stars, or swore that only the clouds are real. The monarch of mountains, crowned with a diadem of snow, furnished him no inspiration. He never saw tears in the drooping eyes of the modest violet. The cowslip's chalice held no gold for this chemist. He did not muse on the circumstance that each blade of grass, though useless in its isolation, helps to form the green mantle that covers the bare shoulders of Mother Earth. The tints of morning, when the young sun rises in splendor to illumine a universe, never stirred his primitive instincts. The murmuring waters and the distant hills, that make orators eloquent and young girls sentimental, were only bosh to him. The wan and melancholy moon that causes youths and maidens gay to exchange tender vows, never affected the systole and diastole of his cardiac region. He walked out in the dusk after the twilight, not to hear the notes of philomel, but to escape the gaze of man. Blind to beauty and deaf to melody was this individual. No wonder his biographers Cuvier, Thomson, Kopp, forgot he was born in Italy—where his mother had gone for the benefit of the waters. The words sublime and beautiful were not in his vocabulary—so he could not have written Burke's essay. His lack of the esthetic sense could be observed in his laboratory, for he never cared how ugly his apparatus looked, so long as it was as accurate as possible. In his dry soul, there was not an atom of the artist. He did not even see the poetry of physics.

And to think that only a stroll from his Clapham villa lived Blake the esthete, going mad with dreams of color, piping himself into paradise with gorgeous phrase.

Voltaire said, "When a woman is no longer acceptable to man, she turns to God," but this cutting sarcasm, like most androcentric epigrams, equally fits the sterner sex. Half the decadent poets, rejected of men, died in the numbing arms of the Catholic Church. Did Cavendish turn to Jesus Christ for comfort? He did not; he never attended a place of worship, and had no religion. It is thought he left Cambridge without a diploma, because he did not care to submit to the theologic red-tape required of all candidates for degrees. Evidently, he was unwilling to argue about Eve's serpent, Elijah's sparrows, Jonah's whale, or Balaam's ass. During his geological trips he used his chisel every day in the week, and some of his most important discoveries in chemistry were made on Sunday. Shall we therefore say he violated the commandment, "Remember the Sabbath day to keep it holy?" Shall we not rather demand wherein is it unholy to add to the treasure-house of Science?

Theologically speaking, Cavendish lived in a backward age —the age in which the fanatical Autocrat of English Literature cast a slur on every liberal thinker in Europe, while the priggish Boswell stood by, clapping his little hands in glee. Johnson would remain on his knees in prayer for hours at a time—except when he had previously taken a dose of squill.

Cavendish's unbelief was both remarkable and refreshing, for of all people in the world the Anglo-Saxons are the most offensively pious. For example, when Captain Cook was about to make his second voyage around the world, the discoverer of nitrous oxide was invited to accompany the expedition in the capacity of naturalist. Priestley agreed to the proposition, and already had visions of strange stars and savages, but he was rejected by the clerical members of the Board of Longitude, not because he was deemed ignorant of science, but because he was unable to feel himself entangled in Adam's guilt.

The same generation that saw an infuriated mob break into Priestley's home at Birmingham, tear his manuscripts into shreds, destroy his electrical apparatus, and smash the earthenware that Josiah Wedgwood sent him, witnessed all Paris entertaining David Hume—the skeptic whose pen scratched the word "miracle" from the domain of truth.

So Cavendish existed: without affection for Man, without interest in God, without belief in Satan; and when he passed out of the world, almost in his eightieth year, no one was at his bedside: no heir, servant or scientific acquaintance; neither doctor, lawyer nor priest,—not even a faithful heart-broken dog. Buddha would have hailed Henry Cavendish the greatest of Occidentals—he had no desires.

Thus far, this has been a narrative in the negative. We have overused "not" and "never"; Cavendish was not this, and Cavendish never did that. But Cavendish must have been something, for although he dreaded the loud hand of applause and quivered at the glaring eye of notoriety, his memory has survived the vicissitudes of a century, while millions of men who fought for fame have dropped into forgotten graves.

Eminent as Cavendish was in his day, he would have been more celebrated had he possessed any desire for distinction. But his place in chemistry is analogous to that of Edward Fitzgerald in poetry, who made "efforts to remain within the shadow of anonymity." A number of Cavendish's papers were published in the *Philosophical Transactions,* but often he would perform a series of experiments, write out the results, and then put the MS. away; twenty years later he might publish it, as he did his *Experiments on Heat,* or he might leave it unpublished as he left his *Density of the Atmosphere of the Earth and of Jupiter.* The unfortunate result of this habit was that scientific men would have to spend considerable time making abstruse researches with which Cavendish was already familiar.

For instance, Michael Faraday had to discover for himself the difference of the capacities of various substances for taking part in electric induction, but had he been permitted to peer into Cavendish's drawer, he would have learnt that that owlish individual had not only discovered that rosin, shellac, wax and glass have higher specific inductive properties than air, but had even determined the numerical ratios of each. Biot also added a new wrinkle to his forehead pondering over problems which Cavendish had previously solved. Even Volta, after whom we have named an entire department of electricity, was forced to make experiments to which Cavendish already knew the answer.

The mind balks at Cavendish's unconcern for laurels: researches which would have established a deathless reputation, electrical memoirs which Clerk Maxwell has been glad to edit, were never sent by their author to a printer. How opposite from the lively Priestley, whose manuscripts would be put into pica before the concluding paragraph was blotted and dried. But Cavendish could not escape immortality: he who does superb work is in danger of being remembered.

Cavendish was a natural philosopher: master of several branches of science. We write of him chiefly as Cavendish the Chemist, but another could call his essay Cavendish the Electrician; a third could tell of Cavendish the Mathematician; a fourth could speak of him as Cavendish the Meteorologist; a fifth could describe Cavendish the Geologist; and a sixth could fill a paper on Cavendish the Astronomer.

We have few such men nowadays, because each separate part of each different branch of science has developed so enormously, that Specialization is necessarily the cry of our age. The German professor who spends twelve years tickling the roots of plants, and writes three weighty tomes on the theme, is undoubtedly an expert on certain botanical problems, but he can know only enough zoology to distinguish a zebra from a kangaroo.

We gladly turn from the pitiful picture of Cavendish in society, to the nobler one of Cavendish in his laboratory. Undisturbed by others, he performed his experiments with a patience that never tired, and an accuracy that has been the marvel of succeeding ages. His great merit lies in the fact that so much of his work was quantitative as well as qualitative. The name of Cavendish is a synonym for exactitude.

This does not mean that he made no mistakes, for the sponge of science has erased more than one of his conclusions. Most of his blunders were due to his adherence to the phlogistic doctrine. This theory of Becher and Stahl, that every combustible substance contains a constituent given up in burning, called phlogiston—from the Greek word phlogistos, meaning inflammable—has now vanished as completely as Kunckel's notion that every metal contains quicksilver, but in its day it worked much havoc.

Phlogiston was indeed the will-of-the-wisp of chemistry which confused Priestley, puzzled Watt, upset Boerhaave, deceived the wise Scheele, lured Kirwan on to error, and often led Cavendish astray.

Chemistry can never be too grateful to Lavoisier—plagiarist though he was on at least two occasions, trying to steal the discovery of oxygen from Priestley, and the discovery of the composition of water from Cavendish—chemistry, we say, can never be thankful enough to the illustrious French savant for exposing the fallacy of phlogiston. Out of the whole phlogistic jargon, only a single word survives in modern chemical nomenclature: eudiometer.

Among Cavendish's early experiments was an investigation of the properties of arsenic, by which he learnt that arsenical acid contains more oxygen than does arsenious, and the latter more than the metal.

He introduced the word "equivalent" into chemistry, and proved that the combining proportions between base and acid follows a distinct law.

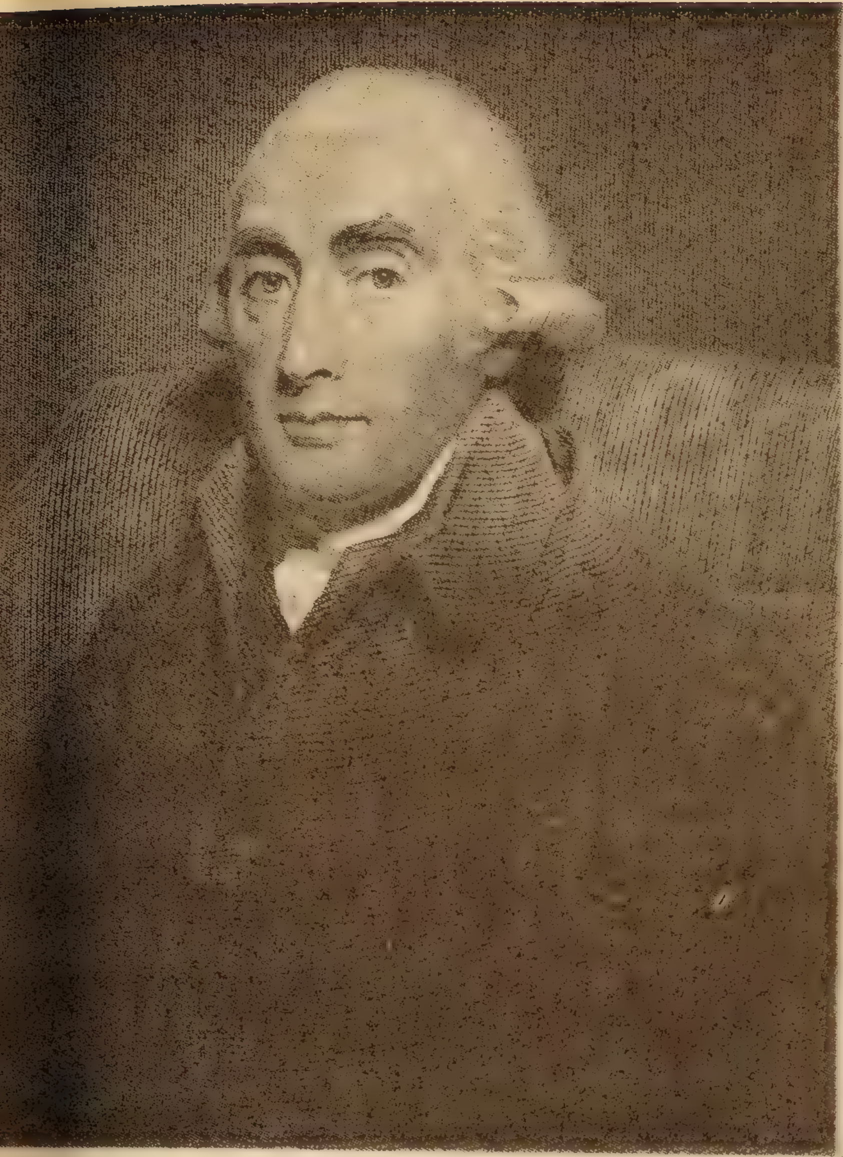
He analyzed the Rathbone Place water, thus making one of the earliest satisfactory analyses of a mineral water; he was the first to explain what is known as the hardness of water; he showed the solubility of bicarbonates of lime and magnesia in water.

He was selected by the Royal Society to describe their meteorological instruments, and Cavendish did not disappoint the Fellows by his account of the rain-gauge, hygrometer, variation-compass and dipping-needle. It should be remarked that his father, Lord Charles Cavendish, was a meteorologist of distinction.

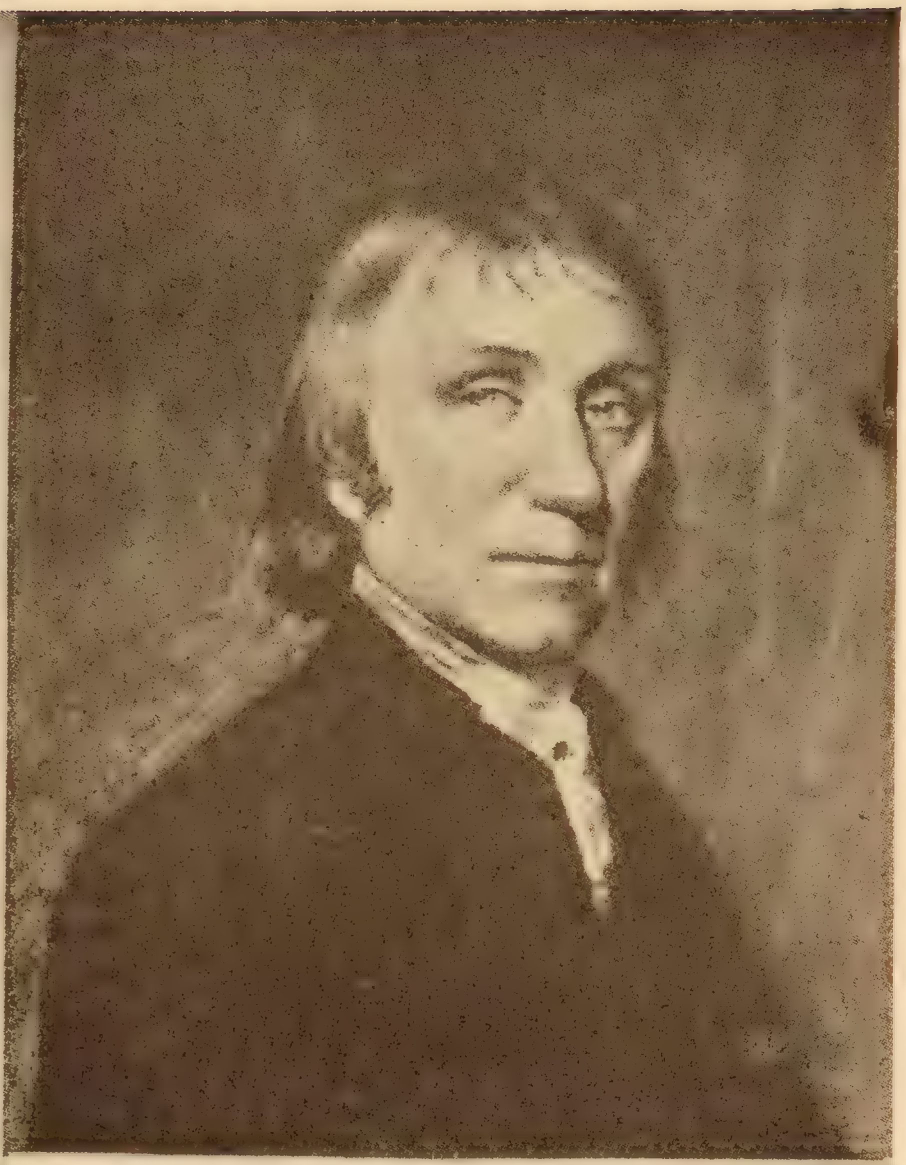
No one could graduate thermometers with such skill as Cavendish; he was always fortunate where mercury was concerned; he and Priestley initiated the method of using quicksilver to collect and preserve certain gases which are absorbed by water.

Rutherford is usually regarded as the discoverer of nitrogen, but Cavendish, like Scheele of Sweden, was an independent finder of the inert element, and wrote the first clear description of it as a distinct gas.

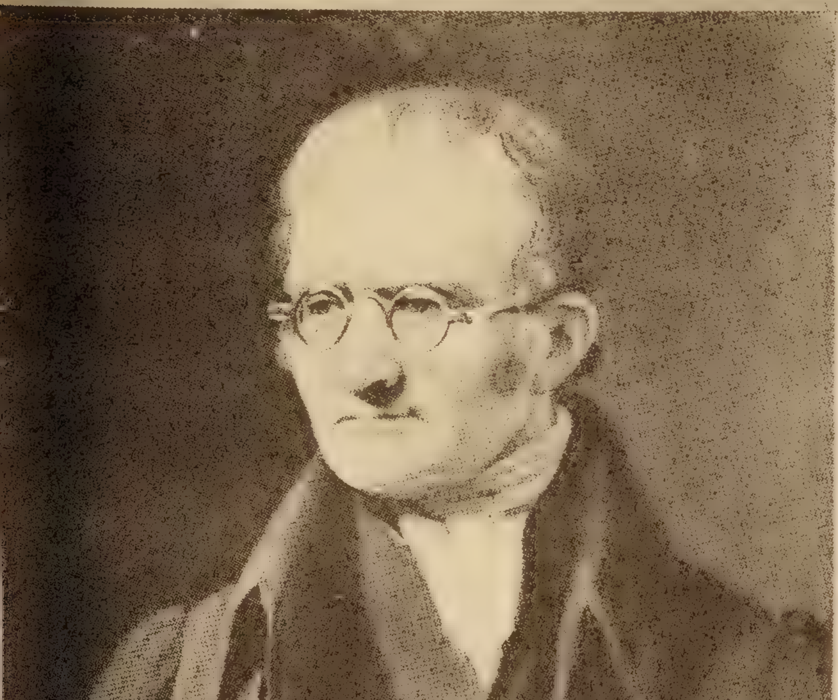
He gave the best account of carbonic acid and the carbonates; he knew that cold water dissolves more carbon dioxide than hot. It is safe to say, however, that he never guessed how important a part carbonic acid gas would play in the great American beverage, nor how often the enamored swain would



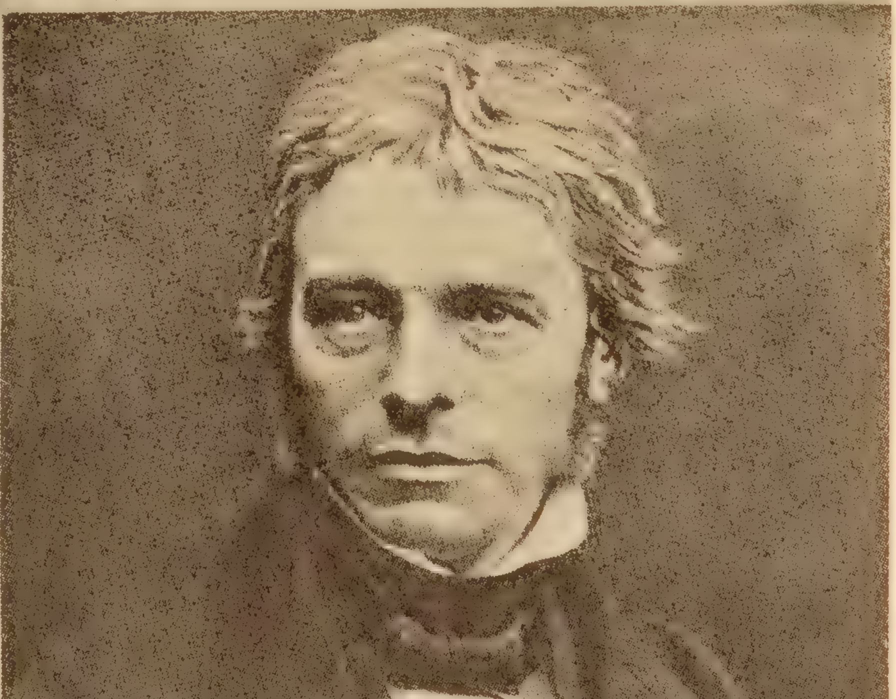
JOSEPH BLACK (1728-1799)



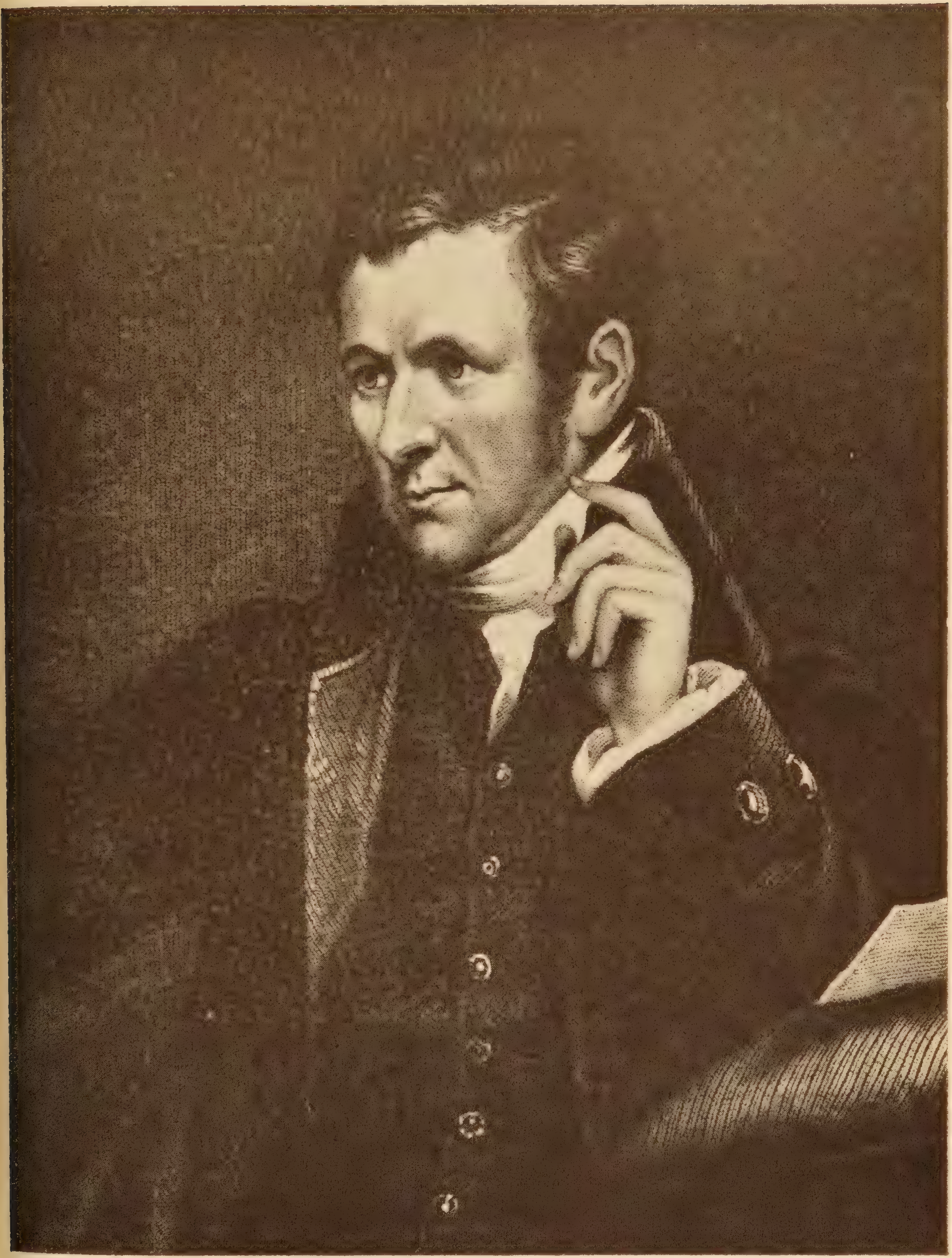
JOSEPH PRIESTLEY (1733-1804)



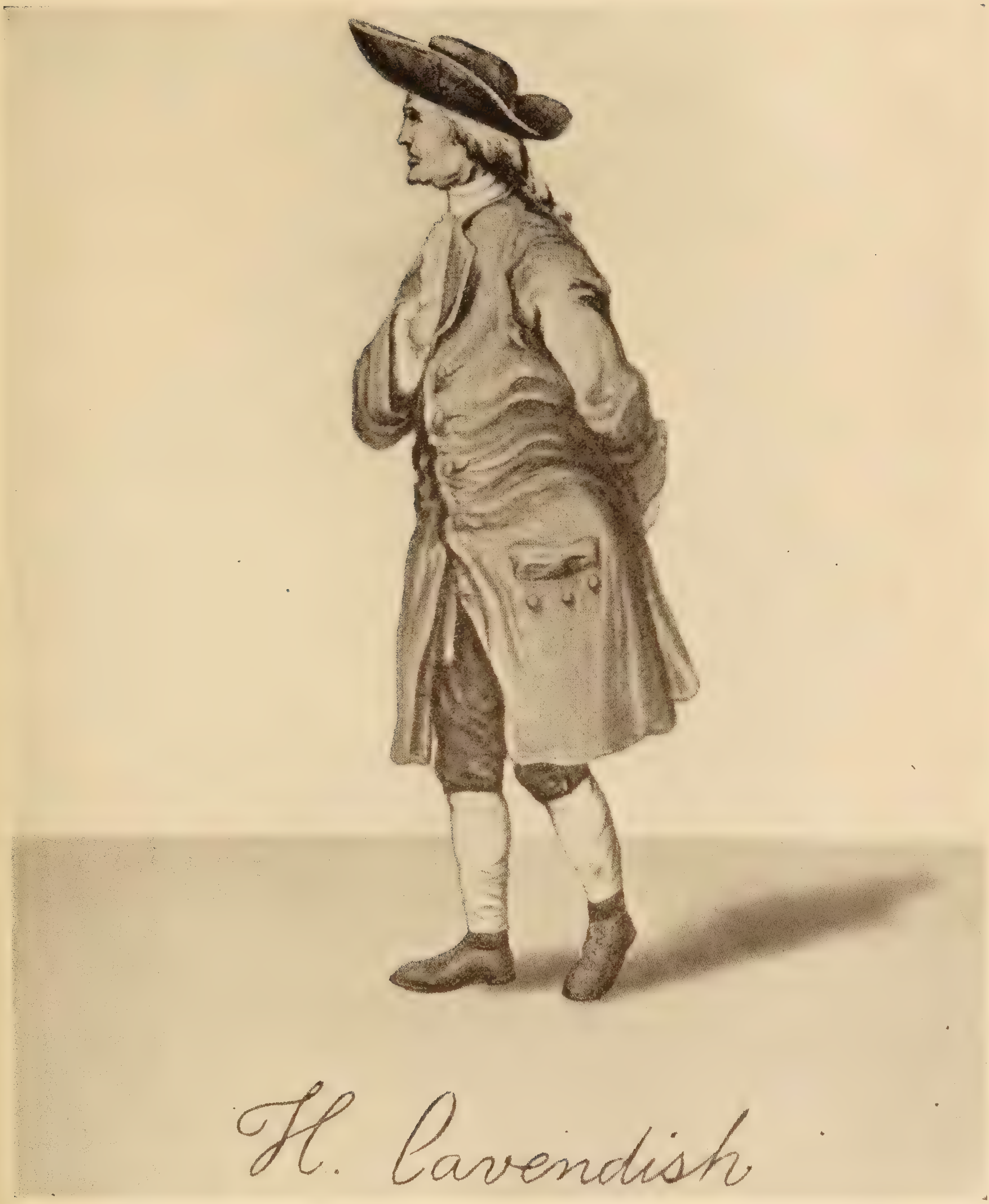
JOHN DALTON (1766-1844)



MICHAEL FARADAY (1791-1867)



HUMPHRY DAVY



H. Cavendish

THE BROTHERS MONTGOLFIER
From an engraving picked up along the quays of the Seine.

inquire of his perspiring affinity, "Will you have a glass of soda-water?"

Cavendish found that a solution of one part of salt in one part of water conducts a current 100 times better than fresh water, and that a saturated solution of sea-salt is 720 times as efficient. "Among the cultivators of electricity," says Professor Chrystal, "Henry Cavendish is entitled to a distinguished place."

The value of his research on the nature of heat was second only to that of Black. He was probably the first who collected tables of specific heats of various bodies, for Cavendish revelled in figures as a poet wallows in adjectives.

For an example of his circumspection, we may quote a passage from Wilson: "We find Cavendish collecting the elastic fluids on which he experimented, with various precautions to secure their purity, observing carefully from how many different sources they could be procured with identical properties, and determining with numerical precision the relative volumes yielded by different processes. The questions of their permanent elasticity, their solubility in different liquids, their combustibility or power to support combustion, their specific gravity, and likewise their combining equivalent, were all carefully inquired into."

During the winter of 1759, Professor Braun was at St. Petersburg, and when the Russian chill sent the quicksilver 34° below Fahrenheit's zero, the Professor stuck his thermometer into a freezing mixture of snow and nitric acid. Immediately the hydrargyrum descended with great rapidity, and after adding fresh supplies of the freezing mixture, Braun watched the mercury fall as low as –352°. He then removed the thermometer, breaking the bulb, and his astonished eyes saw what had never been seen before: solid mercury. Instead of an eternal fluid, he had before him a metallic mass which could be hammered like lead.

"So mercury can solidify," correctly quoted the surprised Professor as he blew on his frost-nipped fingers, but he forgot to take into account the phenomenon that mercury contracts, becomes denser and therefore sinks when congealed, and he accordingly promulgated a grave error: that the freezing point of mercury is about four hundred degrees below Fahrenheit's zero.

Some years later, at the request of the Royal Society, Governor Hutchins at Fort Albany, Hudson's Bay, repeated this experiment, and confirmed the result. But Hutchins could not determine, even approximately, the point at which mercury passes from the liquid to the solid state, for when the mercury is enclosed in the thermometer it is impossible to see how much of the contraction is due to cooling and how much to congelation.

Cavendish, however, understood the true nature of congelation, and—like Black—knew from experiment that when a liquid is undergoing solidification, its temperature, after it first begins to freeze, remains stationary until it is entirely frozen. With this principle in mind he constructed an apparatus which was sent to Hudson's Bay. By employing it, the Governor learnt that the congelation point of quicksilver is only –39°, and that its rapid descent through several hundred degrees, which Braun and he himself had observed, proceeded merely from the contraction which the mercury underwent in the act of freezing, and not from the degree of cold produced.

Cavendish deserves much credit for saving scientific men from the absurdity of accepting fantastic notions of temperature.

His naval ancestor, whom we have previously mentioned, was the third man who sailed around the world; he himself was the first who weighed our terrestrial home. He performed the experiment by means of the torsion balance which had been invented by John Michell, a gentleman who would have been his friend, had Cavendish been able to respond. Out of the endless number of experiments that have been performed in science, only a few have become phrases and passed into technical literature with their author's name prefixed; for instance, Torricelli's Experiment, Oersted's Experiment, Scheiner's Experiment, and Cavendish's Experiment. Just as the first is invariably known to refer to the discovery of the principle of the mercurial barometer, the second to signify a phase of electromagnetism, the third to mean a phenomenon in vision, so the fourth alludes to the density of the earth. Cavendish's Experiment is outlined in the majority of elementary text-books on the science of energy, but we will not use Macaulay's favorite expression, "every schoolboy knows," because we have gone to school, and we know that every schoolboy forgets.

Yet the most retentive of us may have a dim recollection that in Daniell's *Principles of Physics,* we had to study an account of Cavendish's Experiment which read somewhat as follows: "This was a direct measurement of the attraction of masses for one another. Light balls were poised on a rod and their position carefully noted; large balls of lead were carefully brought near them; the light balls were attracted by the heavy masses, and their displacement measured. Great experimental precautions were necessary, such as the observation of the position of the balls with a telescope placed at a distance, the avoidance of draughts of air and of vibrations; the result showed that if lead balls had been employed as large as the earth, the attraction of such balls would have been greater than the actual attraction of the earth in the ratio of 11.35 to 5.67; but lead is 11.35 times as heavy as water, hence the earth as a whole is 5.67 times as heavy as an equal bulk of water; or the density of the earth is 5.67."

He analyzed the atmosphere, his estimation of the mean composition of air in 100 parts by measure, being oxygen 20.8 and nitrogen 79.2. According to the modern computation the ratios are oxygen 20.9 and nitrogen 79.1.

Cavendish guessed the existence of another gas in the atmosphere, and even surmised its amount. One hundred and ten years later, two skillful English scientists—by an interesting coincidence working near the house where Cavendish had lived—repeated Cavendish's experiments, and learnt that the nitrogen obtained from the air was a half per cent. heavier than the nitrogen procured from chemical compounds, such as nitrous oxide, nitric oxide, ammonium nitrate. A closer investigation of this phenomenon led to the discovery of argon in the air. So we see that Lord Rayleigh and Sir William Ramsay found and proved what Cavendish had only prophesied, but they had at their service means of absorbing nitrogen, methods for liquefying air, and above all, spectrum analysis. That is why a couple of bubbles in a capillary tube opened a new era in theoretical chemistry.

Cavendish was not exactly the first who investigated the specific gravity of gases, but he was the first who ascertained that they have different densities. His specific gravity for carbon dioxide was 1.57; ours is 1.524: admirable precision for a chemist whose apparatus we would relegate to a museum of antiquities.

Hydrogen had been casually noticed by Paracelsus, Boyle, Mayow; and indeed, many experimentalists who had thrown acids on metals had seen a gas rise, but Cavendish is considered the discoverer of the lightest substance known, because he made the first investigation and wrote the first distinct account of its properties. It is fitting that Cavendish should have described hydrogen, for the gas is symbolical of its discoverer—having little desire to unite with anything else, being invisible, and trying to escape when confined.

He found hydrogen 11 times lighter than common air; we now know that hydrogen is 14.4 lighter, but as his predecessors could not distinguish any difference between the gravity of hydrogen and the atmosphere, and believed all gases to be of equal weight, his approximate calculation is astonishing. But of course this was Cavendish's only function in life—to weigh things and measure them and analyze them.

Cavendish's discovery of the lightness of hydrogen was the nucleus around which developed a daring and noble art:

Among the picturesque hills of Annonay, dwelt old Peter Montgolfier, manufacturing paper-bags that brought him comfortable money. He had two sons, Stephen and Joseph, who helped him in the business, but also spent considerable time reading Priestley's and Cavendish's essays on different kinds of air—and watching the clouds on high. They wondered what would happen if they could imprison a cloud in a bag: would it rise and float above their heads, sailing beyond the church-steeple and over the tree-tops?

It was not so easy to catch a cloud, but since hydrogen was so very light, why not try that? They did make the attempt, though an unsuccessful one, for the paper proved permeable to the gas. But the sons of Peter Montgolfier were prejudiced in favor of pulp, and instead of abandoning the paper as an unsuitable envelope for the gas, they sought for another gas more suitable for the paper.

Smoke ascended: every naked savage knew that. If a bag should be filled with smoke, would it not also ascend? How strange that some restless intellect, an Aristotle or a Paracelsus or a Newton, had never thought of it!

The Montgolfier brothers filled a bag with smoke, and the bag arose; they raised their hands, but the heated air carried the bag beyond their reach—higher than any house in the village. So the first balloon sailed in a little town that had nothing to make it famous except a Gothic church built in the fourteenth century.

The Montgolfiers came to Versailles to amuse the French court; and as Louis XVI and Marie Antoinette required all they saw to be gorgeous, like their too-ornate palaces and over-gilt carriages, the balloon was showily painted with ornaments in oil. An osier cage was suspended at the bottom, and in it were placed a sheep, a cock, and a duck: the first aerial passengers—except of course the birds that travel on the wing. The balloon mounted to a height of 1500 feet and remained in space till the hot air acquired the temperature of the surrounding atmosphere—in eight minutes—and then descended in the wood of Vancresson, two miles distant. The sheep kicked the cock, hurting its right wing, but otherwise there were no accidents. Thus, amid the masque of powder and the scent of patchouli, was born the art of aeronautics.

Naturally these experiments excited every alert mind: Would man learn to aviate the atmosphere? Would the fabled wings of Dædalus become realities? Young Jenner made a balloon of his own, and old Euler was all agog. Leonard Euler was the greatest mathematician of the century. The hand of the potter did not shake when he was molded: he had a giant's strength and an intellect that matched. But Euler abused his privileges. In three days he solved a problem that took other experts months. He found the answer, but nature protested. Euler sank to his bed in a fever, and when he rose, there was no sight in his right eye. The mighty man laughed, and continued his work. A cataract formed in his left eye, making him practically blind. But Euler did not cease his investigations. Then Wenzell came to the mathematician, and couched his cataract, and Leonard Euler once more saw his wife and children. "Take care," said Wenzell, but Euler studied day and night, till sight left him again. But Leonard Euler worked on. He was throwing light on every phase of mathematics—how could he stop for his own physical darkness? Age advanced upon him, but he continued his researches, dictating memoirs on planetary perturbations, perfecting integral calculus, creating the subject of partition of numbers, inventing the calculation of sines, nearly squaring the circle, winning prizes from even the Bernouillis. Scornful of infirmities, his magnificent activities would have exhausted a score of lesser men. He had long passed the allotted years of the psalmist when he heard of the ascensions at Annonay. The mathematical theory of the motion of a balloon engrossed a mind that knew so well the motions of planets. The skilled hand grasped the chalk, and when great Leonard Euler was dead—having ceased to calculate and to breathe at the same moment—

his blackboard was found covered with his last investigation: the rate of ascent of a balloon.

At this time a balloon was constructed in Paris by the brothers Robert, under the direction of Jacques Charles. The latter gentleman was a professor of natural philosophy, and desired that his balloon—which was of silk, and varnished with a solution of elastic gum—be filled with hydrogen instead of hot air. For a few days the gas was prepared by throwing five hundred pounds of dilute sulphuric acid on a thousand pounds of iron filings, but one day the balloon disappeared from its accustomed spot, the Palace des Victoires. Too great a crowd had gathered there, and during the night, preceded by torches and guarded by soldiers, the precious object had been conveyed to the largest open space in Paris, the Champ de Mars. The next day a cannon-shot gave the signal for the ascent, and the balloon circled three thousand feet above the immense sea of faces that watched below. The rain descended, wetting the balloon and drenching fair ladies, but no one paid any attention to the shower. For three quarters of an hour the balloon sailed in the elastic fluid, finally falling in a field where some frightened peasants tore it to fragments.

But the superiority of inflammable air—as hydrogen was then called—over hot air was demonstrated, and the future of balloonery was assured. Some scientific experiments of value were performed by means of the balloon, as can be seen without leaving Cavendish's own work: Cavendish, as mentioned above, determined the composition of the atmosphere, showing the exact relation between its two most important ingredients, nitrogen and oxygen. He made hundreds of experiments which proved that the composition of the atmosphere is constant, it being immaterial whether the air to be analyzed is collected on fair days or foggy, or from the pure country or the sooty city.

This led some chemists, such as Prout and Thomson, to maintain that the air must be a chemical compound. But John

Dalton, discoverer of the Atomic Theory, correctly insisted that the air is merely a mechanical mixture of constant composition. He believed, however, that since nitrogen is lighter than oxygen, the relative amount of the two gases varies at different heights from the earth's surface, the nitrogen increasing and the oxygen diminishing as we ascend.

To see if this were true, Gay-Lussac collected the atmosphere in the streets of Paris, and also gathered air in a balloon at an elevation of seven thousand meters, for the chemist who climbed Vesuvius when the volcano was vomiting violently, was likewise the most enthusiastic aëronaut of the day. His analysis, which has since been placed beyond doubt, proved there was no change in the proportion of nitrogen and oxygen. In this work, Gay-Lussac was aided by Thenard, who by his discovery of hydrogen peroxide has become the father of thousands of blondes.

The laboratory method of Cavendish was not only orderly, but organized. He did not leap from subject to subject with the speed that Priestley forsook one road of research for a more novel path. Priestley performed his experiments with enthusiasm and ease. He was a great man and a careless one. He would announce a new theory before breakfast, reject it at lunch, and formulate another at the supper-table. He made discoveries or mistakes with equal nonchalance.

Priestley was like a wonderful child amusing himself with apparatus. For the "entertainment of a few philosophical friends" he performed what he called "a random experiment," which consisted in exploding hydrogen and oxygen in Volta's electric eudiometer. After the spark had passed, a dewy deposit was found on the sides of the glass, but Priestley paid no attention to the moisture. This was by no means the only occasion on which the versatile doctor had an important discovery nearly in his hands, and brushed it aside for a more cautious observer to pick up.

Among the philosophical friends who witnessed Priestley's experiment was John Warltire, who wanted to know whether heat is heavy, and with this object in view he burned the gases several times, and weighed the flask after the explosion and after it cooled, reaching however the incorrect conclusion that heat is a ponderable body.

At this time Cavendish was working with the air, and as soon as he heard of Priestley's and Warltire's experiments, he repeated them. He took greater precautions than Warltire, and finding no difference between the first and second weighing, satisfied himself that heat is not a material entity.

Nor did he disregard the deposit of dew which Priestley passed by so heedlessly. On the contrary, Cavendish considered it as "likely to throw great light on the subject and well worth examining more closely."

Various explosions were now heard in the Cavendish laboratory, till it was ascertained that when one volume of oxygen is detonated with two of hydrogen, the gases combine to form a liquid which proved to be water!

Since the dawn of inquiry, when man first speculated on the composition of substances, water was considered an element. Egyptian magician, Chaldean priest, Greek philosopher, Arabian alchemist, German iatro-chemist, and all subsequent chemists looked upon water as a type of an indivisible substance, which could not be decomposed into anything simpler. Microscopic monocellular organisms of the plant and animal world, daily splitting up water into its component gases for their daily needs, knew better, but they could not write text-books. The Honorable Henry Cavendish, who resided on the corner of Montague-place and Gower-street, near the British Museum, was the first human being to know that water is a compound, capable of being built up from its elements. It was a synthesis that advanced the science of chemistry. Did the eyes of this strange man glisten with a little joy?

Yet his views on the nature of water were not as certain as the modern conception. He was prevented from seeing too clearly by the bandage of phlogiston.

On certain occasions, while detonating common air with hydrogen, Cavendish obtained not only water, but traces of nitric acid. At that period there was not a chemist in Europe who could have explained the occurrence, but Cavendish with his intellectual bull-dog tenacity, attacked and stuck to the problem till he discovered that its production was due to the nitrogen of the atmosphere which had combined with the oxygen and hydrogen.

Joseph Black, founder of the chemistry of the gases, considered this discovery "as one of the most important in the whole science of chemistry." The veteran was so enthusiastic because of the light which it threw on the theory of his beloved science.

It explained, for instance, the production of nitrates in the soil. Long before a speck of protoplasm thought of becoming a man, the lightning flashed and converted a portion of the atmosphere into nitric acid, and the rains washed the aqua fortis to the earth, but it was reserved for Henry Cavendish to supply the key for this closed door.

Certainly, an imperfect life; a life that too forcibly recalls Browning's complaint:

> Each life's unfulfilled you see,
> It still hangs patchy and scrappy;
> They have not sighed deep, laughed free,
> Starved, feasted, despaired, been happy.

Hands that never helped a friend, and never fought for the world's prizes; lips that never trembled with rage, and never knew the kiss of love; a heart that never sank in sorrow, and never rose in ecstasy. Passions, none; emotions, absent; fellowship, blank; but he weighed the earth, he experimented with fire, he analyzed the air, he discovered the composition of water. Earth, Fire, Air and Water—the original elements of Empedocles: let us honor the brain that enlarged the boundaries of knowledge.

(1742–1786)

KARL WILHELM SCHEELE

It is not merely as an investigator and discoverer, but as a high-principled and unassuming man, that Scheele merits our warmest admiration. His aim and object was the discovery of truth. The letters of the man reveal to us in the most pleasant way his high scientific ideal, his genuinely philosophic temper, and his simple mode of thought. "It is the truth alone that we desire to know, and what joy there is in discovering it!" With these words he himself characterizes his own efforts.

MEYER: *History of Chemistry.*

We may regard Scheele not only as having given the first indication of the rich harvest to be reaped by the investigation of the compounds of organic chemistry, but as having been the first to discover and make use of characteristic reactions by which closely allied substances can be detected and separated, so that he must be considered one of the chief founders of analytical chemistry.

ROSCOE: *Theatise on Chemistry.*

XIII

KARL WILHELM SCHEELE

It is pleasant to linger on the outside of the École de Pharmacie of Paris, not because of its curriculum, but because its façade holds the medallions of the masters of the gallipots. Here are the historic apothecaries: Nicolas Lemery, Albert Seba, Gilles Boulduc and Etienne François Geoffrey—much mercury has been extinguished since their generation walked beneath the hanging alligator.

There is old Moses Charas—a clever man, but what a mistake he made in Toledo! He should have remained in his native France, but driven abroad by the brutal Revocation of the Edict of Nantes, he tarried a time in England, then lingered in Holland until the king of Spain invited him to the southern land. Charas settled near the river Tagus, in the city of white marble and red jasper. While Charas was gaining a reputation as an authority on venoms, a churchman of that region was canonized, which caused the archbishop to proclaim that henceforth the vipers of Toledo would lose their venom. Moses Charas was over seventy years of age: he thought of his reputation, and the book he had written on the subject, and in the presence of witnesses he performed an experiment. He put a viper of the vicinity and some chickens together, and since they had not read the archbishop's proclamation, the adder bit the fowls with fatal results. Charas had studied deeply in the lore of venoms, but he reckoned without the venom of vanity. Another proclamation was issued, accusing Moses Charas of impiety, and the septuagenarian scientist, on the ground of "attempting to overthrow an established belief," was conveyed to the prisons of the Inquisition.

Much more might be said about Charas—we could tell how his famous Pharmacopœia came to be translated into Chinese—but there are Nicolas Houel, Achille Valenciennes, and the enthusiastic Rouelle—he who began his lectures in full academic costume, and growing animated as the discourse proceded, cast off his cap and gown, and other wearing apparel, including his periwig. Despite his excitement, no chemist of his generation had so clear a conception of the term "salt."

Here are the makers of modern science to whom clung the odor of sal ammoniac in their youngish days: Lavoisier, Humphry Davy, Liebig, Claude Bernard and Dumas—where is Berzelius? See Parmentier who introduced the potato into France, and Jussieu who gave coffee to Europe. Homage to Pelletier and Caventou, the last of the great pharmacists, who isolated the alkaloids quinine and strychnine. That is Pierre Robiquet, who looked for quinine in coffee, but found caffeine instead, and extracted codeine from opium.

Is not that earnest-featured young man the Swedish apothecary, Karl Wilhelm Scheele? Then we must indeed uncover to that glorious and pathetic name. Other illustrious names crowd upon us—Vauquelin and Berthollet, their pupil Thénard and his successor Balard—but we must pause before Scheele. . . .

What a strange creature Poetry chose for her pioneer—a blind man who begged his bread through seven towns. But was not Philosophy's founder similarly odd—a bow-legged, bald-headed fellow, with goggle eyes and a sunken nose, who displeased the authorities and drained a cup of conium. And it seems that Pharmacy was equally amiss, for its prophet was an invalid who passed his days in poverty, and died young—dreaming of test-tubes. Yet gibe not at these men. The centuries uncover to them. Where are the towns that refused food and welcome to the inspired singer? They are blotted from the map, and if they still linger in the memory it is only because their unworthy streets were once trod by the feet of the poet. Does the courthouse in which it was decided that the philosopher must quench his immortal thirst with hemlock still dare to stand?

No, but the bust of the intellectual martyr adorns the niches of a thousand museums. And that little drug-store out in Sweden that couldn't pay its expenses has taken off its sign, but the experiments which the chemist performed in that obscure village will never be removed from the sanctuary of science. Places are swallowed up, cities disappear, nations decay and kingdoms perish, but an unusual man marches through the aisles of ages, never to be lost.

Amebæ may be identical, but the minds of men differ: Keats had the poetic instinct, and Scheele the scientific spirit. Keats was apprenticed to an apothecary, but he cared more for poems than pills, and sometimes when he mixed an ointment there came to him a sunbeam with fairies floating in the ray. He was a child of Apollo, not Æsculapius, and the lustrous parent claimed his favorite son. The pestle was not for the fingers that held poesy's pen, and he exchanged the gallipots of the counter for the galaxy of the heavens, and instead of the dried remains of collected beetles, he searched for the iridescent butterflies that shake their damask wings among the morning-glories.

Scheele was sent to a school of languages, but he was more interested in acids than ablatives, and the miracles that take place in a test-tube had for him an awful fascination. And soon in Bauch's drug-store was a new clerk, aged fourteen. Little Karl Scheele had begun to rinse bottles, and to wipe the dust from the jars that were seldom used. He removed all dirt from the stem of the funnels, and when he cleaned the metal mortars their polished surfaces reflected back his earnest features. And he told his brothers and sisters all about it, for his parents had ten children besides himself, but what their names were we really do not know. After Bauch sold his business at Gothenburg, Scheele assisted apothekers at Malmö, Stockholm and Upsala.

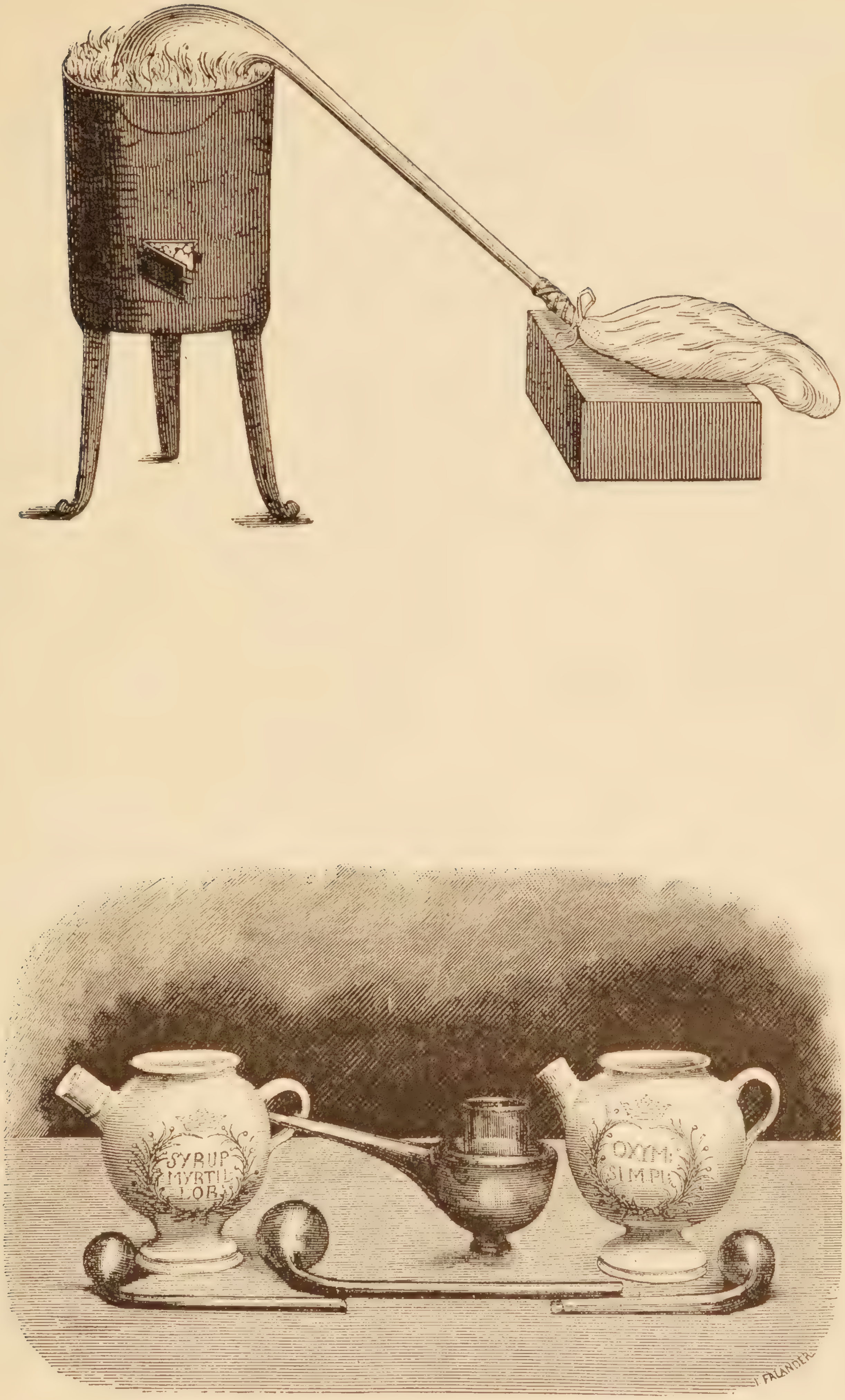
Scheele's original work was done mainly at night. It was then he saw what was never seen before. When the moon glorified the firmament, and a thousand starry orbs looked out, strange power came to him, and he planted his foot on untrodden ground. In his skillful hands the crucible became a sesame that unlocked the door of nature. His spatula was a magic wand that brought forth unknown things. He filled his capsules with the powders of research. His tongs pulled hot coals of fact from the boiling caldron of knowledge. With the bellows of reason he fanned the fires of truth. When his condenser was heated with experiment, it was discoveries that distilled over. Hark, how the midnight was startled by the bubbling of Scheele's alembic!

There came a time when physics no longer ministered to the ailing body of the apothecary of Köping. Purges were tried, but without avail; balsams and liniments helped not, and it was apparent that Hinrich Pascher Pohls was beyond the reach of prescriptions. He left the privileges of this pharmacy to his young widow, who upset Scheele greatly by her proposition to sell these rights to another. This meant that Scheele would have to leave Köping, and he received calls from Falun, Alingsas, Upsala, Stockholm, and from foreign regions. Scheele, however, was a prophet honored in his country, and when the whole village of Köping rose in his favor, even the enterprising widow backed down: Scheele became the town's apothecary, and she became Scheele's housekeeper. Scheele's reply to Bergman regarding the flattering invitations reveals his character: "I cannot eat more than enough, and so long as I can obtain enough I need not seek my bread elsewhere."

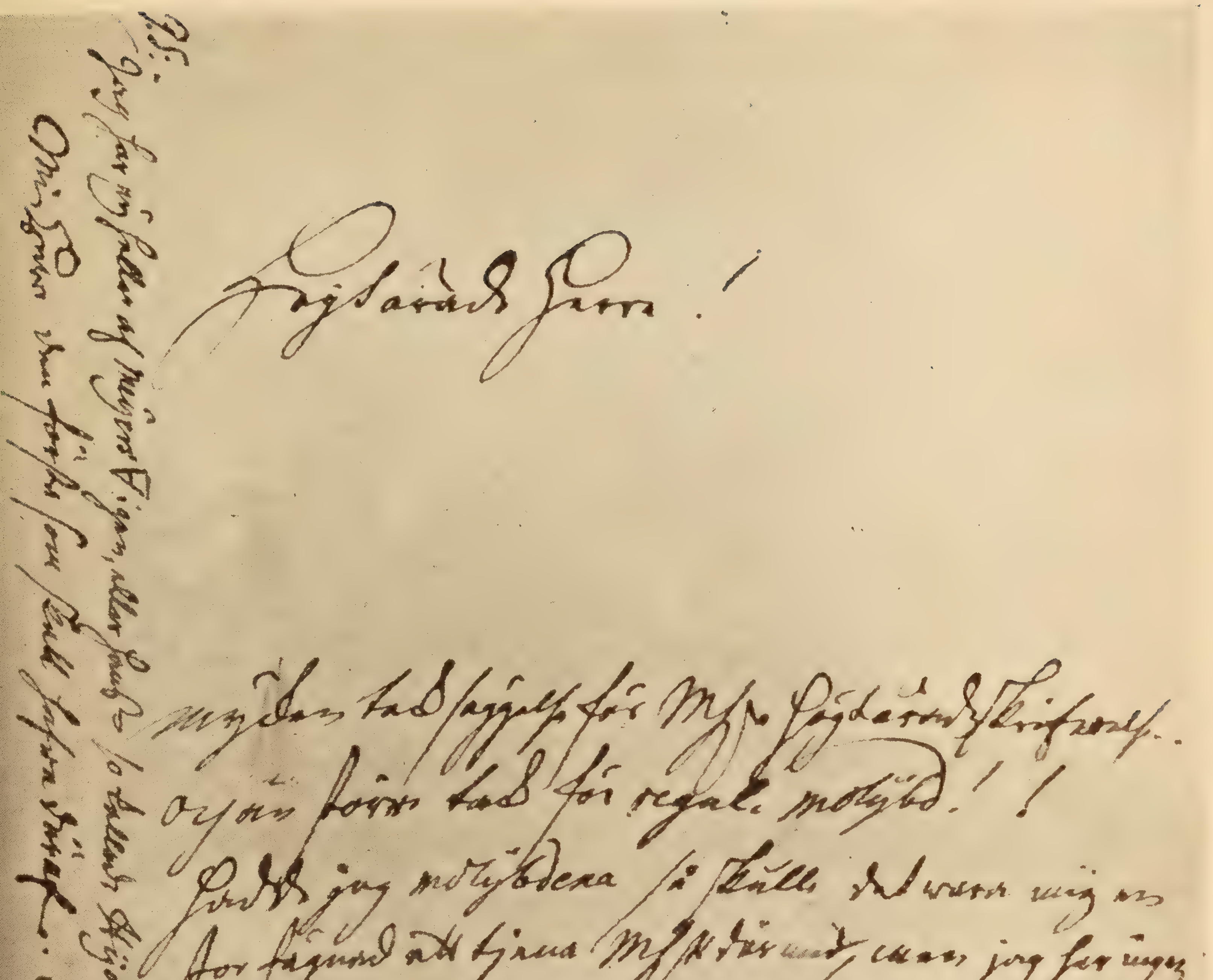
But Scheele was not to obtain this bread with ease, for the drug-store was burdened with debt. (To-day his statue stands in Stockholm, but in those days he couldn't pay his bills.) Finally business improved, but in the course of his arduous experimentation Scheele lost his health. In order that the widow might inherit all his property, Scheele wrote a will in her favor and married her. (The woman who had the right to bear the name of Scheele soon exchanged it for another.) With her apothecary's privilege, and three apothecaries as husbands, Sara

SCHEELE

Portrait reproduced in centenary monograph published at Köping in 1886 by Dr. P. T. Cleve, professor of chemistry in the University of Upsala.



APPARATUS USED BY SCHEELE



Högtärade Herre!

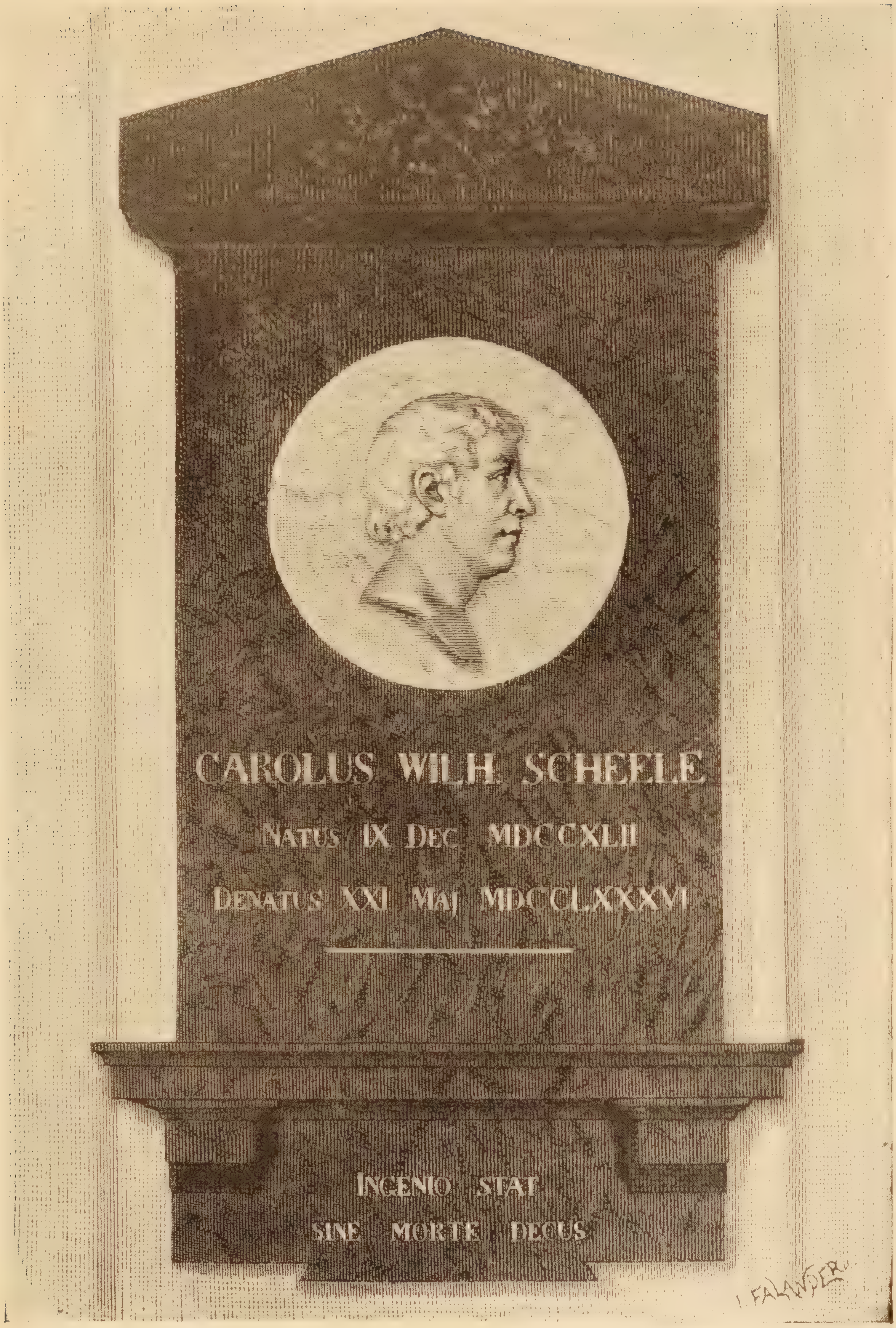
Min ödm. tacksäjelse för M. H:s Högtärade Skrifwelse.
och ännu förra tack för regal. [illegible]!!
Hadde jag möjligheterna så skulle det wara mig en
stor fägnad att tjena M. H:s därmed, men jag har ingen
tijd til arbetets slut om d. historien!
Wid något tilfälle kan M. H:s sända mig detta
tryckta Papperet åter.

Förlåt hastigheten.

Jag är städse
M. H:s! ödmiuk tjenare
Scheele

P.S.: Jag har ej heller af Meyers Eijern, eller hans så kallade Hydrosiderum: får jag något, så är
Min Herre den förste som skall hafwa däraf. vale

LETTER WRITTEN BY SCHEELE
Courtesy of Dr. Erik Waller.



IN THE CHURCHYARD OF KÖPING

STATUE OF SCHEELE IN STOCKHOLM

Margaretha Sonneman occupies quite a niche in the annals of pharmacy.

Science seemed jealous that Scheele should take another mistress, and two days after his marriage he died. He had no children—so all chemists could call him father. Perhaps it is better so. Like so many other great men, he might have become the sire of pigmies. Intellectual giant that he was, from his loins might have sprung a race of dwarfs. Aurelius was noble, his son was a monster; Cromwell was mighty, his child was a weakling; Goethe was everything, his offspring was nothing. Heredity is a humbug—often.

In estimating Scheele's work we must bear in mind that in his day chemistry had just thrown off the fantastic garb of the alchemists and was hardly accustomed to the scientific clothes which it had lately donned.

It is true that among his contemporaries were great-brained workers like Black, Bergman, Cavendish, Priestley, Rutherford, and Lavoisier; that "the subtill science of holy alkimy" was dead among enlightened men; that the Universal Solvent was forgotten and the Philosopher's Stone unsought for; that he was never asked to compound the following prescription: "Calcine vitriol until it becomes yellow, add mistletoe, hearts of peonies, elk's hoofs, and pulverized skull of a malefactor; distill all these dry, rectify the distillate over castoreum and elephant's lice, then mix with salt of peony, spirit of wine, liquors of pearls and corals, oil of aniseed and oil of amber, and digest on a water-bath one month."

Still at this time Chemistry stood only on Mount Abarim and gazed at the Promised Land which it was not to enter until the ensuing century. Scheele lived in the days when chemists made their own apparatus. He never saw a polariscope, or a balance which weighed a pencil-mark. Had he known a laboratory like Sir William Ramsay's, his actions would have resembled those of his great countryman, Linnæus the Botanist, when he first spied an English wild-flower—the earth would have felt his knees. Above all, the principles of modern chemistry were not there to guide him.

When we remember these handicaps and at the same time recall the immense amount of valuable work he accomplished, we realize what manner of man was Scheele. The pioneer who blazes the trail in an unknown forest, surely deserves as much credit as he who comes leisurely after and helps to widen the already-made path. If the second is the more cultured of the two, he is the less original.

Because of Scheele's devotion to it, mention must be here made of one of the most interesting hypotheses that ever entered into the history of chemistry—the Phlogistic theory. This doctrine which was introduced by Johann Joachim Becher and championed by Georg Ernst Stahl had special reference to the alterability of substances by fire. Its essential feature consisted in assuming that all matter which could burn was a compound, containing at least two constituents. On combustion, one of these remained behind and one escaped. The element which remained was named calyx, the principle which disappeared was called Phlogiston. It corresponded somewhat to the "celestial heat" of earlier chemists. Since this Phlogiston existed in all combustible substances and always vanished on heating, it was believed that every time a substance was burned it grew lighter.

In due time it began to be pointed out that some substances when heated, instead of becoming lighter, become heavier, and that often the products of combustion weigh more than the substances burned. It was shown that when zinc is burned, it changes into a white powder which is heavier than the original metal.

Lavoisier knew that when phosphorus burns, the acid body formed by the combustion weighs more than the phosphorus did. But it takes a long time for a naked fact to destroy a theory intrenched in argument, and defended by dialectics. Yet already the casket of Phlogiston was being prepared, and Lavoisier was the immortal undertaker.

Oxygen was discovered by Priestley and Scheele, nitrogen was found by Rutherford, the air was analyzed by Cavendish, and a great light illumined the mind of the French chemist, and the death-knell of the doctrine of Becher and Stahl was rung. Hitherto, combustion was thought to be due to a chemical decomposition in which Phlogiston escapes, but Lavoisier now accounted for the phenomenom of combustion by chemical combination, oxygen or another element being taken up.

The cover was ready to be nailed to the coffin. And the talented wife of Antoine Laurent Lavoisier—Liebig has told us so—robed as a priestess, committed to the flames on an altar, while a solemn requiem was chanted, the phlogistic system of chemistry.

After Copernicus there was no more excuse for astrology; after Darwin there was no more reason for immutability; and after Lavoisier there was no further justification for Phlogiston. But the roots of pre-conceived notions are long and strong, and take generations to uproot. Only one chemist of that age accepted the new truth. Sole among contemporary scientists, Joseph Black—forever illustrious as the discoverer of latent and specific heat—announced himself an adherent of the Lavoisierian doctrine of combustion. Priestley, Cavendish and Scheele remained firm believers in the phlogistic theory which their researches had done no much to upset.

So Scheele was wrong, but what scientist has made no mistake? Galileo discovered a new heaven, but he laughed when Kepler claimed that the tide was influenced by the moon. Harvey discovered the circulation of the blood, but he saw no merit in Bartholin's researches on the lacteals and lymphatics. Perhaps we must say of these men as Carlyle said of Jesus, "A great mon, a great mon, but he had his limitations."

Science has a sorrowful list of wondrous youngsters who disappeared from life when the brain was still eager, and the spirit ardent. Scheele was one of these. In his forty-fourth year he was added to the roll of short-lived geniuses. Yet though the days of his life were few, he labored long and lovingly, for he was in the service of science, and some of the benefits he rendered her are here recorded:

In 1769 while still in his twenties, he experimented with cream of tartar, from which compound he was the first to isolate tartaric acid. He sent a record of his experiments to Torbern Olof Bergman, the first of the great Swedish chemists who acquired international renown. The professor was a generous friend, but at this time must have been absorbed in his own work, for he failed to convey the paper to the Academy of Sciences at Stockholm, which, however, was later done by Anders Retzius.

As far back as 1669 the alchemist Brandt of Hamburg, while searching for the "philosopher's stone" that converts lead to silver and ennobles brass to gold, distilled an evaporated mixture of urine and sand, and obtained, not the "elixir of life," but—phosphorus. For a hundred years the peculiar phosphorescent element remained a chemical curiosity, costing about sixteen ducats an ounce. But in 1771 Scheele—building on Gahn's observation that phosphorus is a constituent of bone-ash—published a method still used in preparing the light-bringer. Bones are burned to remove all animal matter, and the remaining calcium phosphate is heated with hot sulphuric acid, producing phosphoric acid and calcium sulphate. The acid is then strained from the sulphate, concentrated, mixed with charcoal, and dried in an iron pot. Water escapes and metaphosphoric acid remains. The mixture is then transferred to a fireclay retort, strongly heated, and under the water appears the desired phosphorus.

In 1771 Scheele also investigated the composition of fluorspar and noted that the property of etching glass when mixed with sulphuric acid was due to the formation of an acid which he called fluor acid. Scheele's operations had been conducted in glass vessels and what he really obtained was fluosilicic acid.

In 1774 Scheele showed the difference between pyrolusite (manganese dioxide) and magnetite, which previous chemists had considered identical.

He explained how manganese colorizes and decolorizes glass, and distinguished the salts of the lustrous metal, including the green and purple compounds with potash. In fact, he may be considered the discoverer of this element.

In this year he also discovered baryta (barium oxide), a heavy, whitish-gray, poisonous compound, used for plate-glass manufacture, in color-making, and in the preparation of oxygen by the Brin process.

This should have been enough for one year, and Scheele ought to have remembered that Nature herself sleeps half the time, but instead of that he discovered chlorine by treating manganese dioxide with hydrochloric acid. Scheele thought this gas was a compound and called it dephlogisticated muriatic acid. Its elementary character was established in 1810 by Davy who named it chlorine on account of its greenish color.

Nor was this all, for this self-same fertile year saw his discovery of oxygen—independently of Priestley's revelation—by heating manganese dioxide to redness in an iron or clay retort. Subsequently Scheele found an improved method of obtaining this gas—by heating manganese dioxide with sulphuric acid. When manganese dioxide is heated alone, 100 grams of it yield 8.51 liters of oxygen; but when treated with sulphuric acid, 100 grams produce 12.82 liters of oxygen. The reaction is now familiar to every novice, and medical and pharmaceutical colleges ask it in the early quizzes. He shrewdly speculated as to its function in respiration and the growth of plants, and computed the amount of oxygen in the air correctly. The term oxygen (so named by Lavoisier) means "acid producer" and is therefore a misnomer, as all acids do not contain oxygen. Hydrogen should be called oxygen, because all acids contain hydrogen.

Previous to the discovery of oxygen, Daniel Rutherford of the University of Edinburgh, observed that by absorbing the carbon dioxide produced by respiration in an enclosed volume of air, the remaining gas would support neither combustion nor respiration. But it took a long time for scientific news to reach the sequestered (to use Washington Irving's favorite adjective) Swedish town in those days, and just as Scheele had discovered oxygen independently of Priestley, he also discovered nitrogen without knowledge of the Scottish naturalist's observation. Scheele was the first then who demonstrated, by analysis and synthesis, that the air consists mainly of two gases, one supporting combustion and the other preventing it.

The year 1775 was as stirring for Scheele as it was for the English colonies in America. The price of potash salts was increasing enormously, and attempts were made to produce the carbonates from common salt. The French Academy of Sciences offered 2,400 livres to any one who would succeed in converting salt to soda. Scheele at once solved the problem, and made soda from salt by means of litharge. He did not, however, use the much-needed prize-money for any purpose, for he received not a sou.

Scheele separated benzoic acid from benzoin by combining it with a salifiable base and precipitating it with an acid. Later Scheele prepared it from urine by the decomposition of hippuric acid. When benzoic acid is taken into the system, it unites with glycocin with the elimination of a molecule of water, and is excreted as hippuric acid. We have thus an excellent instance of synthesis performed in the marvelous laboratory of the human body, which needs no Friedrich Wöhler. Scheele next investigated arsenic acid, a colorless crystalline compound used in calico-printing. This led to his discovery of arseniureted hydrogen.

By adding a solution of copper sulphate to sodium arsenite he obtained the grass-green salt of cupric arsenite. This powder is well-known as Scheele's green. It is exceedingly poisonous, is used as a pigment, and in the treatment of anemia, diarrhea, enterocolitis, and cholera morbus. He made researches into the constitution of clay, quartz, and alum. He experimented with calculus, from which he was the first to secure uric acid. By heating sulphur with hydrogen he obtained hydrogen sulphide, and was the first to investigate this terror of the laboratories.

Scheele's name is intimately connected with the origin of photography, for it was he who scientifically investigated the darkening action of sunlight on silver chloride. Further, by means of a prism he threw the colored band of light upon a surface sensitized with silver chloride and noticed that the violet rays blackened it more readily than the other colors of the spectrum. By utilizing Scheele's experiments Thomas Wedgwood, of England, produced a photograph.

Of course, there is rarely an absolutely new discovery in science, and if we wish to go a little further back we can see Johann Schulze working by a window—when the weather was warm and the sun was shining. He wishes to treat some calcium carbonate with nitric acid, and it so chances that the acid he uses has some silver dissolved in it. He pours it on the chalk, the rays from the sun fall on the mixture and turn it black, while Johann is highly amazed to find that the effect of light is darkness!

If we travel back still more we learn that some sort of a beginning of photographic chemistry originated with the alchemists, and if no one has yet demonstrated that Aristotle was the original camera fiend, some one will come to the rescue in the near future. Giving due credit to all concerned, the fact remains that Scheele was the first who applied chemical and spectrum analysis to photography, which in the hands of the skillful has become a noble science and a fine art.

In 1778 he described a new method of producing calomel, the most valuable of the mercurial preparations. He proposed a new way of making the powder of Algaroth, the purgative and emetic named after the physician Algarotus of Verona. He examined molybdenite, which was thought to contain lead. He proved the contrary, and secured from the mineral molybdic acid.

In 1779 Scheele showed that plumbago consists almost wholly of carbon. During this year he published records of his former experiments. In 1780 he discovered lactic acid and showed it to be the cause of sour milk, as the sugar of milk is transmuted to acid. A quarter of a century later, Lagrange and Fourcroy and Vauquelin claimed that Scheele's new acid was merely impure acetic, and though Berzelius—discoverer of sarcolactic acid in the juices of the flesh—combated this opinion, it was only years later, when Liebig and Mitscherlich analyzed the lactates, that the matter was definitely settled.

By boiling milk sugar with nitric acid, Scheele obtained mucic acid. It is a white crystalline powder, practically insoluble in water, and on further oxidation yields racemic acid, an isomeric modification of tartaric acid, first obtained artificially by Pasteur. In 1781 he discovered the composition of the vitreous mineral tungsten. It has since been called Scheelite. He obtained from it, tungstic acid, which by means of nitric acid is precipitated as yellow crystals from solutions of tungstates. In 1782 he experimented with that highly volatile and inflammable liquid, ether.

In 1783 Scheele boiled olive oil, litharge and water to get lead plaster. He obtained the plaster, but noticed also a liquid which was strange to him. He tasted it; it was sweet, and he called it the "sweet principle of oils" but to-day we call it glycerin! So another important reaction was written down on Scheele's scroll. What substance known to pharmacy is more indispensable than this thick, oily, mawkish fluid?

The remaining years of Scheele's life were devoted to the products from the acid saccharine fruits. He thus completed a cycle, for his first and last discoveries were made in the wide domain of the vegetable acids. He extracted citric acid from lemons by a process still used. The boiling juice is first completely saturated with finely powdered calcium carbonate, and the resulting precipitate of calcium citrate allowed to subside. When it is repeatedly washed with water and decomposed by dilute sulphuric acid, an insoluble calcium sulphate separates out, and the coveted citric acid remains in solution. This is then carefully concentrated in leaden boilers until a pellicle begins to form, when it is transferred to other vessels to cool and crystallize.

In several of the world's pharmacopœias citric acid has for its immediate neighbor another of Scheele's discoveries—gallic acid. Malic acid is likewise in Scheele's Document of Discoveries. The most interesting characteristic of malic acid is that it furnishes us with a remarkable example of physical isomerism, for when naturally obtained it rotates the plane of polarization, but when artificially prepared is optically inactive.

On oxidizing sugar with nitric acid, Scheele obtained an organic acid which he named saccharic acid, now called oxalic acid. Scheele likewise discovered hydrocyanic acid obtained by him from Prussian blue.

It was once believed that Scheele himself was suddenly killed by inhaling the vapors of the terrible poison he discovered, and it is true that Prussic acid has ended the career of more than one subsequent chemist—and countless non-chemists—and it undoubtedly helped to ruin Scheele's health.

The note-books of Scheele which excited the wonder of Anders Retzius and all who have seen them, were filled with experiments, simply expressed, and often occupying only a few lines; they resemble at times the experiments recorded in a freshman's note-book—except that Scheele's had never before been performed or interpreted. The manuscript of Scheele's great book, *Treatise on Air and Fire,* was placed in the printer's hands in 1775, but was not ready for distribution until the latter months of 1777—under less provoking circumstances, Schopenhauer sent an exceedingly nasty letter to his publisher, but there was no bitterness in Scheele's soul. His collected chemical papers appeared in German, French, English and Latin—this tribute, like most honors in this world, being posthumous.

The series of experiments which Scheele conducted in connection with Prussian blue—laying the important foundation of our present knowledge of cyanides—has excited the enthusiasm of modern chemists, and with a tribute on this topic from the learned pen of Professor John Ferguson of the University of Glasgow, we close our meagre account of Scheele's momentous work:

> In 1782–1783 appeared a research which—of all those Scheele conducted—exhibits his experimental genius at its very best. By a wonderful succession of experiments he showed that the coloring matter of Prussian blue could not be produced without the presence of a substance of the nature of an acid, to which was ultimately given the name of prussic acid. He showed how this body was composed, described its properties and compounds, and mentioned its smell and taste, utterly unaware of its deadly character. Nothing but a study of Scheele's own memoir can give an adequate notion of the manner in which he attacked and solved a problem so difficult and complicated as this was at the period in the history of chemistry when Scheele lived. . . . His accuracy, qualitative and quantitative, considering his primitive apparatus, his want of assistance, his place of residence, the undeveloped state of chemical and physical science—was unrivaled. He grudged no labor to make the truth indisputable; and he evidently never considered his work complete about any body unless he could both unmake and remake it. For him chemistry was both an analytic and a synthetic science, and he shows this prominently in his researches on Prussian blue. . . . The one aim of Scheele's life—and he never swerved from it—was the experimental discovery of the truth in nature.

This was Scheele's aim. Whose aim was higher? This is what Scheele did. Who has done better?

High are the pointed peaks of Sulitelma, O Sweden! where the cooling cataracts rush down the crags of the mountain. In the Baltic is the island of Oland, whose rocks of Silurian limestone have battled for centuries with the god of storms. Near the North Cape rises a mighty slab of granite, thousands of feet in height, with every niche containing the nest of an Arctic bird. Calm are the waters of Maelar, and the falls of Motala turn the wheels of many mills. The lake of Vener is large, and Tornea Elf flows down to the sea. Famed is the hill of Kinnekulle, and who knows not the forest of Kolmorden? Uto is rich in the ores of iron; copper is found in Falu, and silver at Sala. There are mines of magnetite and hyperite, of granulite and dolomite. Among the trees of fir and pine the elk and roe deer search for browsage, and the fleet-footed hare leaps through the brush. Droves of leaping salmon crowd the rivers, and the herrings swim from the sea to spawn in the shoals. Over the snowy fields the great-horned reindeer wander, the whooper swan sails in the lakes of Lapland, and high in the frosty air soars the gyrfalcon and the golden eagle. Great indeed is the spectacle of the Midnight Sun, and when the Aurora Borealis flashes its dancing columns across the startled skies, the beholder stands with reverent heart and uplifted hand.

Yet boast not of these things, Sweden. Huge kings have sat on thine ancient throne, and hurled stout armies at the frightened nations. But be not proud of them. Do not sing of the Olafs and Erics, and seek not to perpetuate the memories of the vikings of old. We are sick of the bloody sagas of the skalds, and the fierce berserkers who cried Was-hael among the reddish fiords. We have heard quite enough of your battle-axes, and we close our ears at the sound of the hammer of Thor. Forget that victory at Narva, and scratch out the name of Charles XII.

Sweden, greater is thy glory. Thy name is on the lips of thinkers, and when the spirit of Science calls the roll of nations who have served her, thou canst answer in a triumphant voice, for Scheele is thy son.

(1779–1848)

JÖNS JAKOB BERZELIUS

Berzelius's conception is grounded on the consideration of electrochemical phenomena. Its simple and lucid principle is that the new elements are to be so disposed as that each shall be electro-negative to those which precede it, and electro-positive to those which follow it. The series thus derived appears, thus far, to be in conformity with the whole of the known properties of both the elements themselves and their principal compounds. It is too soon, however, to speak decisively of this: and, on the other hand, the chemical preponderance of electric characters is by no means so logically established as to compel us to seek the bases of a natural classification in that order of phenomena. It must, it seems to me, be clearly proved at the outset that the point of departure is a real one,—that is, that a constant order of electrization exists among the different elements, which is maintained under all conditions of exterior circumstances, of aggregation and decomposition: but, not only has this never been adequately undertaken, but there is some reason to apprehend that its result would be opposite to the proposed principle. Whatever may be the issue of future labors, Berzelius has secured the eternal honor of having first exhibited the true nature of the problem, and the aggregate of its principal conditions, and perhaps the order of ideas in which its solution is to be sought. Wherever this solution is obtained, chemistry will have made a great stride toward a truly rational state.

AUGUSTE COMTE.

XIV

JÖNS JAKOB BERZELIUS

Gustav Retzius was a member, not of a family, but of a dynasty, and he was the culmination of the line. His father, Anders Retzius, who gave his name to a group of fibers, a set of veins, a ligament and a space in the human body, was one of the foremost anatomists and ethnologists of his time, and Gustav's grandfather and at least three uncles also gained distinction in science. The childhood of genius is so often marred by unsympathetic parents, that it is a pleasure to linger over the adolescence of Gustav Retzius. He worshipped his surroundings, and his references to his father read like a litany.

Gustav Retzius naturally grew up in a scientific atmosphere. He was born in the Caroline Medico-Chirurgical Institute of Stockholm, where his father, one of the chief creators of the institution, had his home. Next to Gustav's trundle-bed stood a skeleton, and along the window-sill of his room were jars and aquaria filled with infusoria and bryozoans. One of Gustav's early pets was a giant-frog of Brazil that could leap as high as the ceiling. In due time, Gustav was taken on trips to Germany, France and Switzerland, where he heard his father discuss scientific problems with Johannes Müller, Ernst Heinrich Weber, Rudolph Wagner, and Justus Liebig. By such priests was the youthful neophyte of the north initiated into the temple of science.

On one occasion, all the more momentous because the experience was never repeated, Gustav Retzius, a gymnasium student of fourteen, was permitted to sit on the same benches with medical students, to hear his father lecture. With the mimicry which his mobile features made possible, with a vivacity undimmed by sixty years—over half of which had been spent in this lecture-room—Professor Retzius explained the structure and function of the trachea in a manner that aroused the enthusiasm of his entire audience—while one young heart, which really had no business in that auditorium, beat in love and admiration for this extraordinary father.

The bond between them was unbreakable, but it was slender. The boy was so occupied with his lessons at school, and the parent so absorbed in his researches, professional duties and varied correspondence, that for long periods the elder and younger Retzius would meet only at meals. But with the coming of 1860, the bond was to be drawn tighter and unravel itself in a thousand threads. For Gustav Retzius was graduating from the Gymnasium with its much-hated requirements, and that same Spring would don the white cap of the medical student at Upsala. Anders Retzius was not to lose a son, but to gain a disciple, for it was planned that Gustav would soon return to attend regularly his father's anatomical lectures. Dreams of happiness filled the patriarch and the eager apostle, but suddenly, two weeks before Gustav matriculated in medicine, Anders Retzius rested from his labors.

"And thus the leader went away, just as I stood at the threshold," wrote Gustav Retzius, with simple pathos, more than thirty years later. The student awoke from his dream, but the bonds remained unsevered, and invisible threads guided him in all the pathways of science. He edited his father's letters, and collected and published his contributions to ethnology. In his anthropological studies of the Lapps and kindred races, he carried forward his father's work. Perhaps Anders Retzius' chief claim to fame is his achievement in craniometry, and Gustav Retzius early engaged in the researches which thirty-six years later eventuated in the Crania Suecica Antiqua. Gustav Retzius, in the plenitude of his renown, when his name was honored wherever science had a votary, experienced for his father the same reverence that he felt during his Gymnasium-days when he gazed upon him in wide-eyed wonder.

Robert Knox, the turbulent anatomist of Edinburgh, found it expedient to conceal his marriage, but most modern anatomists have wedded with wisdom. Gustav Retzius, blessed in his father and mother, was equally fortunate in his wife, Anna Elizabeth Hierta. She was a devoted and charming companion, and as the daughter of Lars Hierta, the founder of the widely-circulated *Stockholm Aftonbladet,* she brought to her husband sufficient funds to make him financially independent, and enabled him to publish his scientific writings in any form he chose, without worrying about printers' bills. As for the versatile Retzius himself, he proved so adaptable as a son-in-law, that he became editor-in-chief of the *Stockholm Aftonbladet,* and sat in the editorial chair of this daily newspaper for three years.

Like many European physicians, Retzius was not only a skillful technician, but a man of culture. He translated a portion of Robert Burns into Swedish, published a bulky volume of his own poems, and wrote cantatas in memory of his illustrious countrymen, the botanist Linnæus and the chemist Berzelius. Retzius belongs to the scientists who traveled extensively, and his Pictures from the Nile Country, Pictures from Sicily, and Pictures from North America, may stand on the shelf with John Bell's Observations on Italy, and Richard Bright's Travels Through Lower Hungary. Retzius has an added interest for us on account of his connection with the history of science; he wrote fifty biographical sketches of eminent biologists.

Retzius will be remembered for his comprehensive monographs on the internal ear of vertebrates, by his atlas on ancient Swedish skulls, his original description of the brown striæ in the enamel of teeth, his important investigations of spermatozoa and ova, his studies of the cerebrospinal coverings and spaces, his work on the cerebral cortex, the end-organs of nerves, and innumerable other contributions to the histology of the nervous system, and by the eighteen folio volumes of his Biological Researches, entirely written and almost entirely illustrated, by himself. He will be remembered, too, by all who knew him, for his friendliness, graciousness and modesty.

During July, 1919, at the age of seventy-seven, he left us. The newspapers took no notice of his departure. Gustav Retzius did not invade a neighboring country, and call it justice. He did not imprison those with whom he disagreed, and call it statesmanship. He did not stir up national hatred, and call it patriotism. He was not a militarist or diplomatist, but only a man of science, so of course he could not expect to attract public attention. But in the pantheon of science, beneath the great domes of anatomy and anthropology, swings the ever-burning thurible, lit by the hands of Gustav Retzius.

We have referred to Retzius' cantata to the great classifier, Linnæus—who for years, eclipsing all contemporaries, loomed across the scientific horizon. There was much chaos in those days, and more honor was given to Nature's cataloguers than to her interpreters. When Linnæus passed on, it was felt that never again would little Sweden harbor such a mighty man of science. But the very next year—on August 29, 1779—in the parish of Vaversunda, at the foot of Omberg, between the shores of Tåkern and Vättern, the judge's daughter gave birth to a son. That child was Jöns Jakob Berzelius, and thirty years later Sweden had another Linnæus.

The childhood of Berzelius was tangled and complicated, with bitter memories that remained like unfading scars. His mother, who soon became a widow, soon re-married, and soon died; his aunt then took care of him until she herself married; his stepfather, marrying for the third time a widow with several children by a former marriage, sent Jöns Jakob and his sister Flora to their uncle, Lieutenant Sjösten, who was likewise blest with seven children of his own. In this multiplicity of marriages, young Berzelius and his sister were neglected for the more legitimate offspring of the surviving parents. The first lesson he learned in life was that the bitterest crust to eat is that of charity. "My position during these years left such an impression on me," he wrote later, "that I could never share other people's happiness when thinking of my childhood."

To escape his unsympathetic relatives, Berzelius spent many hours wandering in the fields, and unconsciously became a naturalist.

These relatives were relieved when they were able to send him away to the Gymnasium at Linköping, for in spite of his poverty, it was realized that the son of a school principal, the grandson of the district judge, and the stepson of the parish rector could not become a laborer. To earn money to continue his studies, Berzelius became a tutor; his pupils were the sons of farmers, and often were compelled to put down their books and take up the hoe. Mankind can live without pedagogy, but not without plowing. In those days in the vicinity around Linköping, an ox was more valuable than a professor. Even Berzelius, taking a hand in the farm-work, sawed wood. His lodging was not furnished with heat, and during the winter both the tutor and the potato crop which was stored in his room threatened to freeze.

Berzelius was not an exemplary student at the Gymnasium. Disregarding the portions of the curriculum which did not appeal to him, he attached himself wholly to Dr. C. H. Hornsedt, the new professor of natural history, who had just returned from the East Indies. Berzelius collected and described plants and insects for Hornstedt, shot birds for him—and nearly killed a companion by playfully pulling the trigger of the loaded gun when he thought it contained priming powder only. This incident needed a bishop's blessing to save Berzelius from being expelled. With their specimens, Hornstedt and Berzelius planned to build a Museum and write a Fauna Lincopensis, but these projects remained among unfulfilled desires. The relatives of Berzelius kept asking him when he would prepare for the ministry in the manner of his forefathers, but Berzelius had already copied, with his own hand, the Fauna Suecica of Linnæus in its entirety, and that was his Bible. To make matters worse, when Berzelius graduated from the Gymnasium, his name was lowest on the list and some of his teachers called attention to his bad temper and undesirable manners. His alarmed relatives sighed and wondered what would become of that vexatious orphan.

Berzelius, however, did not trouble his relatives, but went to Upsala to study medicine. At the university, he was better understood, and Professor Liljeblad smilingly assured him that the bad marks he received at Linköping would not count against him at Upsala. Berzelius nevertheless remained a difficult student, and becoming embroiled with his professors and the dean, it required the king's intervention to enable him to pass his examinations. On receiving his M.D. in 1802, he immediately departed for Stockholm, and unlike Arrhenius, never returned to Upsala.

Now that examinations were over, the genius of Berzelius was able to develop. It is true that he still encountered numerous obstacles, and often applied for positions which went to others, but from 1802 on, the chronology of Berzelius becomes crowded with years of progress. In that year he was appointed assistant professor of botany and pharmacy at Stockholm, and five years later achieved the full professorship; in 1815 he was elected professor of chemistry at the Caroline Medico-Chirurgical Institute, and three years afterwards became the perpetual secretary of the Stockholm Academy of Sciences. In time his honors multiplied, so that it required several pages of small type to describe them.

Of course, while others watched him mount to the top of fame's ladder, he had his share of human distress. Like many scientists, he invested his earnings, and thus lost his money. Typhoid nearly killed him early in his career; and one careless experiment almost cost him his eyesight; his laboratory-work often ruined his health, and for long periods he suffered from irritability, melancholia, hysteria and migraine. He craved the domestic comforts he had never possessed, but continued to live alone; when he required food, he brought something from the store, and ate his meal and drank his cider in the laboratory—at times interrupting his simple repast to attend to a chemical problem.

Concerning the laboratory of Berzelius, a graphic description has been given by Wöhler: "No water, no gas, no hoods, no oven, were to be seen; a couple of plain tables, a blow-pipe, a few shelves with bottles, a little simple apparatus, and a large water-barrel whereat Anna, the ancient cook of the establishment, washed the laboratory dishes, completed the furnishings of this room, famous throughout Europe for the work which had been done in it. In the kitchen which adjoined, and where Anna cooked, was a small furnace and a sand-bath for heating purposes."

Friedrich Wöhler had received his M.D. at Heidelberg, and intended to prepare himself for medical practice, but Leopold Gmelin—the most famous of the many Gmelins who cultivated chemistry—persuaded him to see Berzelius, and thereafter Wöhler never touched a lancet. In the annals of chemistry, the name of Wöhler logically follows Gmelin and Berzelius, for in 1817 Gmelin said it was characteristic of organic compounds that they could not be produced from their elements, while Berzelius in 1827 wrote that "the elements present in living bodies obey laws totally different from those which rule inanimate nature." In the following year, Wöhler, still in his twenties, accomplished what every chemist had deemed impossible: he created an organic substance from its inorganic elements. Wöhler's preparation of urea demolished the barrier between the organic and inorganic world—and built a bridge instead. He cremated the vital force theory, and from its ashes arose a new conception of the unity of matter. He overthrew an ancient dogma, and cleared the way for the laboratory preparation of complex mineral and vegetable products. Wöhler began with the synthesis of urea, Emil Fischer ended with the synthesis of proteins from their amino-acid constituents, and in this field chemists of the future have only one more problem to solve—the synthesis of albumin, which is protoplasm, which is life!

An interminable essay might be written on scientists who almost made discoveries, but failing to complete the final experiment, saw the credit go elsewhere. Wöhler, who succeeded in isolating several elements, was also on the point of finding vanadium in the slag of some iron ores, but at the last moment it slipped through his fingers, and was disclosed instead, in Poggendorff's pages, by Nils Gabriel Sefström. Wöhler was much vexed, called himself an ass, and complained of his ill luck to Berzelius. His former teacher could not help making a little fun of him, but his letter proves he knew how to apply the balm to the wound:

> As to the small quantity of the body marked ? I will relate the following story: In the far north there lived in the olden time the goddess Vanadis, as beautiful as she was gracious. One day there came a knock at her door. The goddess was in no hurry, and thought, "They can knock again"; but no further knock came, for he who knocked had passed on. The goddess, wondering who it could be who cared so little to be let in, ran to the window and recognized the departing one. "Ah," said she to herself, "it is that lazy fellow Wöhler! He richly deserves his name, since he cares so little to come in." Some days after, some one else knocked, repeatedly and loud. The goddess opened the door herself; it was Sefström who entered, and as a consequence, vanadium came to light. Your specimen with the ? is, in fact, vanadium oxide.
>
> But he that has found the mode of artificially forming an organic body can well renounce the discovery of a new metal; indeed, one might have discovered ten unknown elements without as much skill as is seen in the masterly work which you and Liebig have carried out together and have just communicated to the scientific world.

Wöhler did not remain more than a year under Berzelius, but he had a pleasant habit of forming unbreakable ties with scientific men. When Henri Etienne Sainte-Claire Deville published a monograph without reference to the prior researches of Wöhler, he gave the latter an excellent opportunity for a quarrel—in that era, most chemists seemed to be in a constant state of ebullition, especially if one was a Frenchman and the other a German—but the outcome of the matter was that

Wöhler and Deville not only became lifelong friends, but collaborated in several researches. Wöhler's relationship with Liebig is the Damon and Phintias relationship of chemistry. "Without envy and without jealousy, hand in hand, we pursued our way," wrote Liebig in his autobiographical sketch; "when the one needed help, the other was ready. Some idea of this relationship will be obtained if I mention that many of our smaller pieces of work which bear our joint names were done by one alone; they were charming little gifts which one presented to the other." The imperishable researches of Wöhler are chronicled in the memoir of August Wilhelm von Hofmann, the accomplished investigator of the amine bases, and the biographer of great chemists. The autobiography of Berzelius was translated from the Swedish into German by Wöhler's daughter, Fräulein Emilie.

Among the other distinguished pupils of Berzelius were Christian Gottlieb Gmelin, the discoverer of ultramarine; and the brothers Gustav and Heinrich Rose, descendants of Valentine Rose the elder and younger—it would require a statistician to compute whether the Gmelin or Rose family has contributed more members to chemistry. Gustav Rose later devoted himself to crystallography and mineralogy, explored the Urals and Caspian Sea with Humboldt and Ehrenberg, studied the formation of diamonds, and became the founder of petrography; while Heinrich Rose, after serving in the Prussian army at Waterloo, was the first to study the mass-action of water in various reactions, and is remembered for his discovery of antimony pentachloride.

Johan August Arfvedson, who discovered lithium, and Karl Gustaf Mosander, who worked in the rare earths, being the first to isolate lanthanum and terbium, were both pupils of Berzelius. Since it is not mentioned in any English source, we may add that Berzelius had a transient pupil who became better known with the pen than the stirring-rod: the anonymous but unforgotten author of the Gold-Headed Cane, the ever-interesting William Macmichael.

A more constant pupil was the renowned Eilhard Mitscherlich. Beginning his career as a linguist and orientalist, he succumbed to Persia, dreaming of the old fire-temples and the Gardens of the Nightingale of Ispahān. He came to Paris to beseech Napoleon to permit him to join the embassy he was sending to Persia, but Napoleon was then nearing Waterloo. Hearing that physicians usually enjoyed immunity in traveling throughout the East, he decided to study medicine. His first contact with science at Göttingen aroused unexpected interest, and after he entered the laboratory of Berzelius, chemistry claimed him.

Mitscherlich's discovery of selenic acid, his investigation of the vapor densities of many volatile substances, his improvements of apparatus for analysis, his contribution of a whole series of new compounds to science, and his artificial preparation of minerals, were overshadowed by his discovery of isomorphism, dimorphism and polymorphism, which Berzelius regarded as "the most important since the establishment of the doctrine of chemical proportions." It was Mitscherlich's work in crystallography which definitely sent the young Louis Pasteur upon his immortal quest of molecular dyssymmetry.

The pupils of Berzelius spread the doctrines of the master throughout Europe, becoming professors of chemistry at Berlin, Göttingen, Nürnberg, Würzburg, Tübingen, Greifswald, Freiberg, Durham, Helsingfors, and St. Petersburg.

Berzelius liked to travel and meet scientists of other lands. In this way he came into contact with the two greatest spirits of his age—Humboldt and Goethe. That genial and much-traveled physician, Sir Henry Holland, once met Berzelius at an unforgettable dinner in Paris: "It was at the house of the Countess of Rumford, the widow of Lavoisier, a reminiscence in itself. At the table were seated Laplace, Cuvier, Berthollet, Gay-Lussac, and Prony; Madame Laplace, Madame Berthollet, and Mrs. Marcet. Berzelius, whose acquaintance I had made the same day at the Institute, came in the evening. Such society, so assembled round a Parisian dinner-table, was a singu-

THE YOUNG BERZELIUS

lar treat to a young London physician, and of its date and details I have kept careful record."

At one time, Berzelius remained about a year in Paris, becoming acquainted with the chief scientists of France: the noble and tragic figure of Ampère; Thénard, who rose from a peasant to a peer of France; Dulong, whose injured hand and lost eye perpetually testified to his ardor for chemistry; Arago, the man of a thousand adventures and deeds; Chevreul, noted for a host of researches and for living beyond the century-mark; Laplace, who in his early twenties became "the Newton of France"; Gay-Lussac, who could not count his own discoveries, sailing over clouds and climbing Vesuvius in full eruption, punctilious in the laboratory, illustrious everywhere; Biot, Haüy, Vauquelin, Berthollet—workers who added new chapters to the book of knowledge.

When Berzelius, in 1812, undertook his first journey to England to meet Humphry Davy, it was at the expense of the crown prince of Sweden. Humphry Davy had just married the temperamental and wealthy widow who was supposed to be the original of Madame de Staël's *Corinne* (1807), and he never afterwards took off his high hat. His origin was as humble as John Dalton's, son of a weaver, and grandson of a shoemaker; Davy was the son of a wood-carver, and during his ill-behaved youth was known as "Carver Davy's boy," but having acquired a title by merit and a fortune by marriage, he adopted patrician manners which alienated his warmest friends. Davy took his unblushing bride and young Faraday traveling on the continent, and the lady—who once made a venerable professor in Edinburgh lace her boot in the streets—plagued both scientists to desperation. Not realizing that the ex-bookbinder was about to become one of the greatest investigators of modern science, she treated Michael Faraday as a servant. At Paris, Davy was welcomed by scientific circles with passionate enthusiasm, but puzzled his hosts by elevating his eyebrows. It must not be counted against him, however, that while the French chemists were debating, "What is iodine?" Davy, who had his portable laboratory with him, stole a march on Gay-Lussac, and recognizing iodine's analogy to chlorine, hastily but correctly pronounced it an element.

At London, Sir Humphry Davy received Berzelius as coldly as Sir Hans Sloane had once received Linnæus. Berzelius' friend and biographer, Magnus Martin of Pontin, relates that Sir Humphry in his reception-room was a very lofty gentleman, but when Davy and Berzelius got into the laboratory, "both felt only as chemists." Davy introduced Berzelius to the foremost scientists in the country, and the visitor remained five months in England. Davy and Berzelius were about the same age, their careers and researches often ran in parallel lines, but they did not like each other. Although Davy employed some of the methods of Berzelius in his experiments, and Berzelius generously referred to Davy's first Bakerian lecture as one of the most remarkable memoirs in the history of chemical doctrines, their inability to get along together was so notorious that when the gifted Madame de Staël arrived from Stockholm in London, she attempted peace negotiations.

Years later, Berzelius and Davy arranged to meet in Helsingborg—the hill-crowned Swedish seaport, noted for its iodide and bromide springs—and then undertake a geological journey through Sweden and Norway. While Berzelius and his party waited, Davy, who was a fanatical angler, tarried along the Laga, catching salmon. The biographer of Berzelius whom we have previously mentioned, states that on this occasion Berzelius recognized that Davy suffered from the incurable disease of polyphagia, and after his early death was one of his sincere mourners. The character of Sir Humphry Davy, especially under the influence of the heiress, was not free from serious blemish, but all must acknowledge that he was a master mind, and a benefactor of the human race.

Two years after Davy's death, Wöhler, complaining to Berzelius of his literary burdens, received this reply: "Had Davy been forced to occupy himself as much with writing as you have to do at present, I am convinced that he would have advanced chemistry by a hundred years; but he remained only a brilliant fragment just because he was not compelled from the beginning to work himself thoroughly into all parts of the science as into one organic whole."

We cannot accept this judgment, and it is exceedingly doubtful if investigators of the first rank should be called upon to produce annual reports and textbooks. Wöhler's transformation of the inorganic ammonium cyanate into the organic urea which revolutionized chemistry, occupied only pages 253–256 of Poggendorff's journal in 1828. Johann Christian Poggendorff, the born editor, who refused many offers of professorships in order to edit for over half a century the Annalen der Physik und Chemie, could undoubtedly tell many a story of an important discovery that was announced on one page.

Our reaction may be wrong, and genius seems capable of all things, and certain it is that Berzelius was equally fertile at his writing-desk and his melting-pot. He began to write early in his career, and effectively increased his literary output as the years went on. His experimental researches were usually first published in Swedish in the Transactions of the Stockholm Academy, but many of them appeared afterwards in German in the famous periodicals of Liebig and Poggendorff; some in French, in the Annales de Chimie et de Physique, edited by Gay-Lussac and Arago; and some in English in the Annals of Philosophy, edited by Thomas Thomson, who deserves to be remembered for being the first to give Dalton's Atomic Theory to the world; for establishing at the university of Glasgow the first chemical laboratory in Great Britain for the instruction of students; and for the excellent English he employed in his History of Chemistry.

Berzelius' first published paper was devoted to an analysis of mineral waters (1800), a subject to which Swedish chemists, especially from the time of Bergman, have paid considerable attention; his thesis, when graduating as doctor of medicine, was On the Action of Galvanism on Organic Bodies (1802). Only these two of Berzelius' contributions bear the imprint of Upsala; it was then that he removed to Stockholm, immediately publishing his Treatise on Galvanism (1802), which was followed by his great work On the Division of Salts by Electricity (1803). His essay on the Usefulness of Artificial Mineral Water (1803), brought Carlsbad to Stockholm. His two volumes of Lectures on Animal Chemistry (1806–08), Theory of Chemical Proportions and the Chemical Action of Electricity (1814–18), New System of Mineralogy (1819), the celebrated and much-translated treatise On the Use of the Blowpipe (1820), and twenty-seven volumes of Annual Reports on the Progress of Physics and Chemistry (1821–48), are some contributions in a bibliography which contains considerably over two hundred titles.

Berzelius was not thirty when the publication of his *Lärbok i Kemien,* translated into many languages, made him the chemical schoolmaster of Europe. Originally published in three volumes in Swedish (1808–18), the second Swedish edition of four volumes (1825–31), was translated into German by Wöhler, and the *Lehrbuch der Chemie* became so popular that no further Swedish editions were printed, Wöhler preparing the subsequent editions from Berzelius' Swedish manuscripts—no wonder he groaned at times.

The Philosophical Transactions of London (1813), contain the results of some experiments on sulphur, by Berzelius and Marcet. It was a minor research, and we mention it only because it gives us an opportunity to bring in the unremembered name of Marcet. Physician and chemist, Alexander John Gaspard Marcet, originally of Geneva, later of Edinburgh and London, contributed to the literature of diabetes and mineral waters, investigated black urine, discovered xanthin, and appears to have been the first to point out that stone may grow in the kidney without symptoms, the pain of renal calculus usually resulting from its attempted passage through a ureter. Histories of chemistry now omit Marcet and his wife, the index of the latest edition of the Encyclopedia Britannica contains no reference to them, and yet in the early decades of the nineteenth century their names were on every tongue. Ernst von Meyer refers to Marcet only once and incidentally, but that reference is significant:

> The efforts made by Davy, however, backed as these were by an exceptional talent for devising and carrying out experiments, resulted . . . in an increasing demand for lectures with appropriate experimental illustrations. We know that it was the lectures given by Marcet in London which induced Berzelius in 1812 to abandon the old method of instruction, and to make use of experiments in introducing students to chemical science; and the result of this was conclusive. The subsequent good achieved by Faraday, Liebig, Wöhler, Bunsen, Wurtz, Kolbe, and, especially, A. W. Hofmann, from the new lecture experiments which they devised, requires but to be mentioned. Those experiments and many others have since taken a permanent place in the teaching of chemistry.

Jane Haldimand, only daughter of a wealthy Swiss-English merchant, married Marcet, and added laurels to the name. Jean Baptiste Say pronounced her "the only woman who had written on political economy and shown herself superior even to men." Of these Conversations on Political Economy—which set the pace for Harriet Martineau—Macaulay declared: "Every girl who has read Mrs. Marcet's little dialogues on political economy could teach Montagu or Walpole many lessons in finance." Prior to this, Mrs. Marcet had pioneered in writing one of the first popular books on science, the amazingly successful "Conversations on Chemistry, intended more especially for the Female Sex," which appeared originally in 1806. Males have always been curious about books designed for the other sex, and among those who studied Mrs. Marcet was an awkward youth who developed into an unsurpassed investigator, and wrote to his friend De la Rive a letter of reminiscences which John Tyndall read aloud at the Royal Institution:

> I entered the shop of a bookseller and bookbinder at the age of 13, in the year 1804, remained there eight years, and during the

chief part of the time bound books. Now it was in those books, in the hours after work, that I found the beginning of my philosophy. There were two that especially helped me, the "Encyclopædia Britannica," from which I gained my first notions of electricity, and Mrs. Marcet's "Conversations on Chemistry," which gave me my foundation in that science. . . .

Do not suppose that I was a very deep thinker, or was marked as a precocious person. I was a very lively imaginative person, and could believe in the "Arabian Nights," as easily as in the "Encyclopædia." But facts were important to me, and saved me. I could trust a fact, and always cross-examined an assertion. So when I questioned Mrs. Marcet's book by such little experiments as I could find means to perform, and found it true to the facts as I could understand them, I felt that I had got hold of an anchor in chemical knowledge, and clung fast to it. Thence my deep veneration for Mrs. Marcet—first as one who had conferred great personal good and pleasure on me; and then as one able to convey the truth and principle of those boundless fields of knowledge which concern natural things, to the young, untaught, and inquiring mind.

You may imagine my delight when I came to know Mrs. Marcet personally; how often I cast my thoughts backward, delighting to connect the past and the present; how often, when sending a paper to her as a thank-offering, I thought of my first instructress, and such like thoughts will remain with me. . . .

MICHAEL FARADAY.

Oblivion cannot overtake the name of Berzelius, but eighty years have passed since he rested from his last experiment, and many chemists of to-day apparently do not realize that they are able to see so far because they stand on his shoulders. In Emile Duclaux's book on "Pasteur: History of a Mind," there are three references to Berzelius, in each instance derogatory. This is most unhistorical. Of course, Berzelius, who covered the entire domain of chemistry, made numerous mistakes. At times he defended unsound theories with the tenacity of pre-Lavoisierian chemists clinging to phlogiston; more than once he changed his mind and reversed himself; for many years he regarded nitrogen as a compound; he maintained that oxygen was a constituent of the halogens after Gay-Lussac had proved otherwise; he was the last great chemist to abandon Lavoisier's unsound tenet that all acids contain oxygen; he hesitated to accept isomerism—although the term is his—when Liebig, Wöhler and Faraday demonstrated its existence; moreover, as he grew older, he experimented less and speculated more, thus adding to his errors. We repeat, he made mistakes, just as all others engaged in research, from the days of Aristotle, have made mistakes.

For example, take the case of John Dalton. Crabbed and color-blind, moving in his Quaker garb, as Sir Henry Holland saw him, in his rude laboratory of broken bottles and other uncouth apparatus at Manchester; pronouncing London "a surprising place, and well worth one's while to see once, but the most disagreeable place on earth for one of a contemplative turn to reside in constantly"; scorning to read the works of colleagues, asserting he could carry his library on his back; in reality benevolent, yet declining to discuss his work and saying to interviewers, "I have written a book on that subject, and if thou wishest to inform thyself about the matter, thou canst buy my book for 3*s.* 6*d.*"; indifferent to the investigations and results of others; never revising his opinions, right or wrong; reprinting pet theories, already demolished by facts; refusing to adopt new apparatus or ideas; stubbornly unconvinced in the face of overwhelming proof; preferring his cumbrous circular symbols, as fantastic as the alchemists', to the simple and rational system of chemical notation introduced by Berzelius; falling behind in his own fields of research; unheeding the march of progress in all directions around him; justifying Miss Clerke's dictum, "what he had not himself discovered was to him almost non-existent,"—he seems the very antithesis of a man of science. But underneath his broad-brimmed beaver, John Dalton carried one of the most sagacious intellects that England has produced: aside from his epochal observations on color-blindness, since called Daltonism;

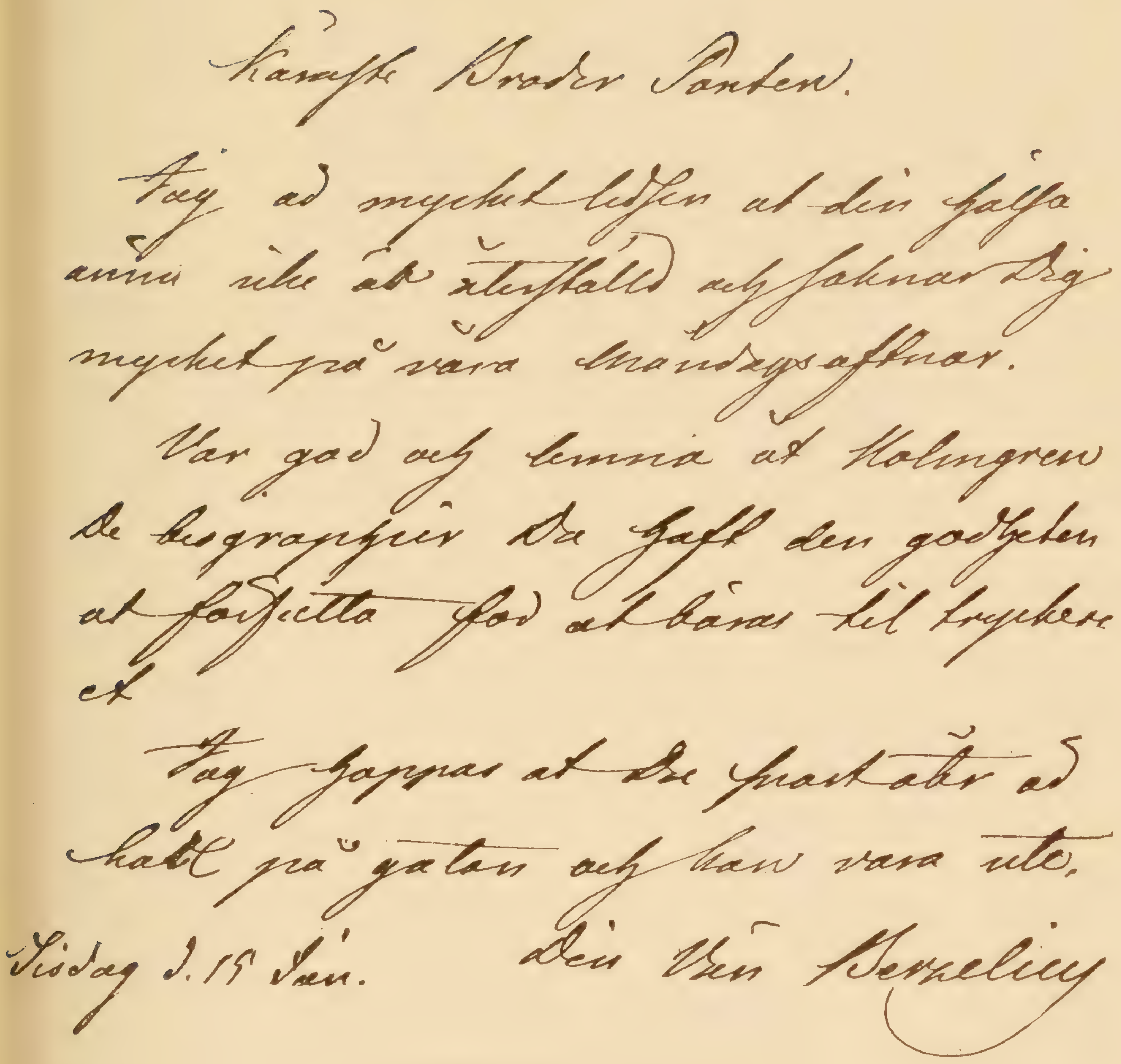
in addition to establishing the principles of volumetric analysis; and creating the science of meteorology; by deducing the law of multiple proportions, followed by his conception of the atomic theory, he solved the most important chemical problem of his time.

No pathmaker in science, blazing new trails for his successors to follow, can avoid entirely the quicksands of deceptive hypotheses. A volume might be written on the mistakes of Newton. The question is not, what were the mistakes of Berzelius, but what were his contributions to knowledge?

In the first place, he taught us the alphabet of chemistry: its vocabulary, nomenclature and notation. The division of the elements into metals and metalloids; expressions such as suboxides, oxides and peroxides; the prefixes and suffixes of chemicals—this terminology is derived from Berzelius.

While others were struggling with weird astrological symbols that no two chemists could draw exactly alike, Berzelius said let O stand for oxygen, H for hydrogen, K for potassium or kalium, Pb for lead or plumbum, Hg for mercury or hydrargyrum, and in this way let the initial letter or letters of the Greek or Latin name symbolize each element; now let us put side by side two elements of one atom each, as PbO, and we thus have the compound plumbi oxidum or litharge; with other compounds we will add a small subscript to indicate the number of atoms in each element that make up the compound, thus water will be represented by H_2O. These formulæ gave chemistry its language, and though the innovation was opposed at the beginning, it now forms part of the education of every child who goes to school.

After Liebig and Wöhler announced the results of their classical research on the radical of benzoic acid—which laid the foundations of the radical theory—Berzelius in his enthusiasm wrote to the investigators proposing that benzoyl be called proïn or orthrin, meaning "morning blush," because a new day had dawned for organic chemistry. In spite of this poetic suggestion, benzoyl has remained benzoyl, but several



Käraste Broder Pontin.

Jag är mycket ledsen at din hälsa ännu icke är återställd och saknar Dig mycket på våra Måndagsaftnar.

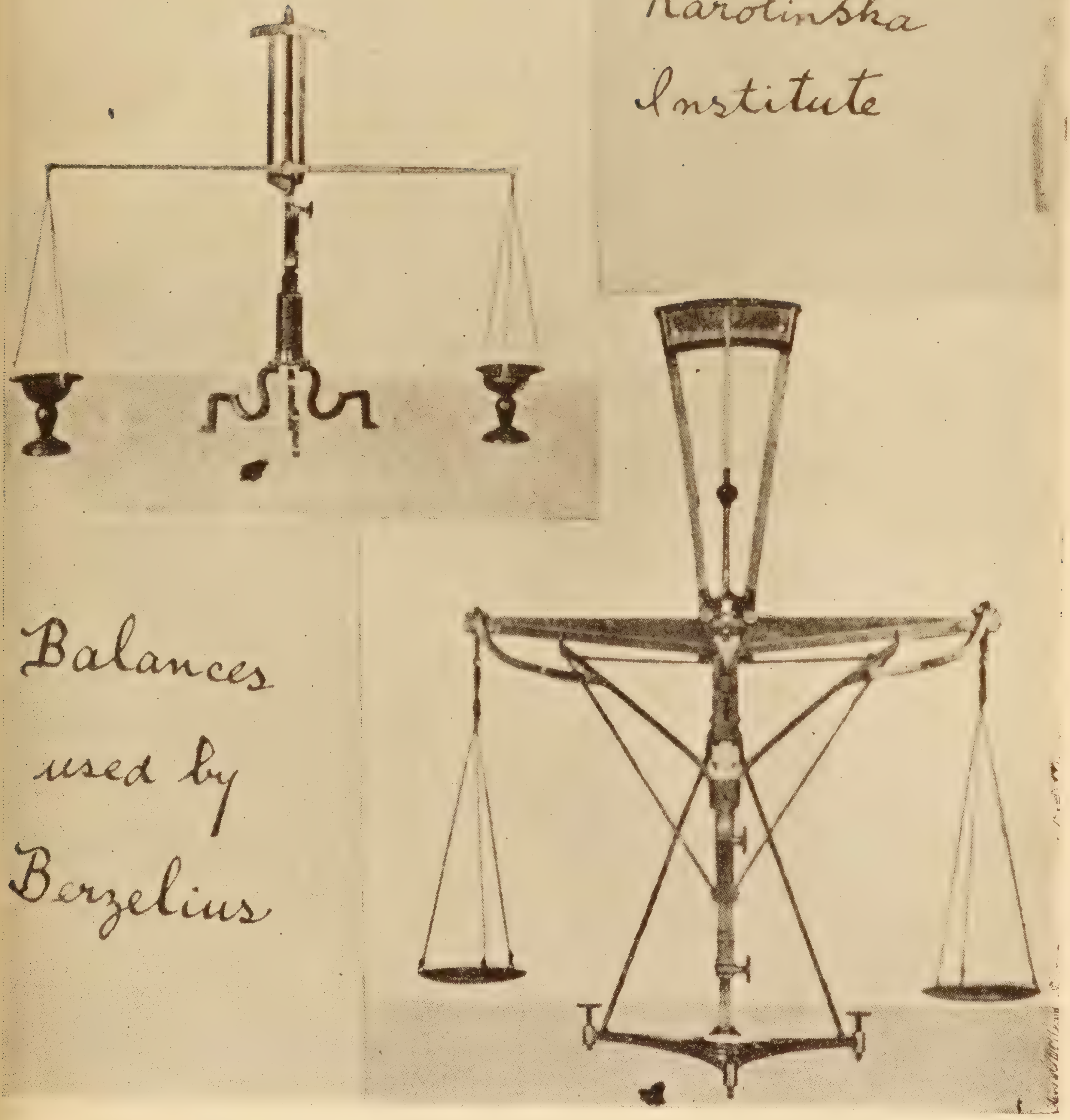
Var god och lemna åt Holmgren de biographier Du haft den godheten at författa för at bäras till tryckeriet

Jag hoppas at Du snart åter är halt på gatan och kan vara ute.

Tisdag d. 15 Jan. Din Vän Berzelius

HANDWRITING OF BERZELIUS

From the History of Karolinska Institute



Balances used by Berzelius

HOUSE OF BERZELIUS IN STOCKHOLM
Where his private laboratory was located (1809–19).

BERZELIUS

terms of Berzelius' devising, such as isomerism and allotropy and the phenomena of contact-actions which he called catalysis, have been permanently adopted.

Dalton was the father of the atomic theory, but Berzelius was its champion. Dalton was a mathematician and deductive thinker rather than an analyst, and in its early days the atomic theory required endless analysis for its survival, growth and development. Berzelius rendered similar service to the law of Dulong and Petit. He could not give William Beaumont any information about gastric juice, but he studied effectively the physiological chemistry of blood, bile, urine, milk, and other animal products. He was one of the precursors of Thomas Graham in the chemistry of the colloids. He was one of the principal workers in mineralogical chemistry—a Hercules with the blowpipe.

Analytical chemistry, since the time of Robert Boyle's introduction of the term "analysis," is resplendent with such names as Marggraf, Lavoisier, Bergman, Scheele, Klaproth, Bunsen, Fresenius, Lampadius, Plattner; a conspicuous place belongs to Berzelius for his improvements and systematization of the blowpipe which brought Cronstedt's instrument into every laboratory. His analytical researches, ranging from meteoric stones and platinum ores to mineral waters; his new tests in gravimetry; his examination of the composition of over two thousand substances, together with his principles for determining their atomic or combining weights, reveal the master chemist.

When Lavoisier was led to the guillotine, his head alive with unfinished experiments, carrying with him to the basket a lost century of chemical progress, Berzelius was a country lad of fifteen. In Lavoisier's day, only twenty-six chemical elements were known, none being discovered by Lavoisier himself. Berzelius extended this number by his discovery of cerium (1803), selenium (1817), silicon (1823), zirconium (1824), and thorium (1828), while his pupils isolated several other elements.

To form some conception of the impetus which Berzelius gave to chemists, we may take a single one of his discoveries, say selenium. Recently (1927) Marion Foster Doty compiled the titles of works relating to selenium in the New York Public Library, and found they numbered 1665. A rather long list of patentees is also appended—from Alexander Graham Bell to gentlemen of Japan—but the name of Berzelius is not among them.

Berzelius had left the Gymnasium with a certificate stating that he "justified only doubtful hopes," and honors may not have descended upon him as rapidly as he desired, but they came in profusion with the mellowing years. The multitude of portraits of Berzelius—paintings, medallions of clay, medals of gold and silver, his features imprinted on iron and bronze, the bust by Ovarnström and the colossal statue by David of Paris—could furnish material to M. H. Spielmann for an Iconography of Jöns Jakob Berzelius. Like Linnæus, he was a Knight of the Polar Star. His own king, and the monarchs of other lands, sent him orders of the first class and grand crosses. In 1828, Berzelius not yet fifty years of age, journeying to Berlin to attend the session of the Society for Research in Natural Science, received homage: as a surprise, he was presented with an edition of his works in Spanish, printed in Mexico; and his bust was placed between Schiller and Goethe. The arsenate of calcium is known as berzelite, and the copper selenide of Sweden and the Harz is named berzelianite. A plant-group is known as berzelia, and within the moon-rays is a spot that bears his name.

We learn from contemporary accounts, that after middle life Berzelius put on weight, retaining the youthful plumpness of his cheeks, and the color of his light brown hair and blue eyes. To judge from the portraits we have seen, he looked more like a portly peasant than a great scientist. In his laboratory he must have had the patience of a saint, and was only nervous and hasty when playing cards.

It has been revealed to the public that even actors and prima donnas have lonely moments, and therefore it is not surprising that at times Berzelius regretted his life in bachelor's hall. Not everyone could be as impassive as John Dalton, who when asked why he had not married, answered, "I never had time." In his mid-fifties, Berzelius was passing through one of his periods of depression. As the Christmas season approached, and all Scandinavia prepared to partake in the approaching festivities, he realized he had no family. As on other occasions, he was invited to spend Christmas-eve at the home of Gabriel Poppius, the college president and city counsellor. Shaking the snow from his coat, entering the warm room of his dear friend, welcomed by the wife and smiling daughters, Berzelius sighed at his loneliness. It was in this environment that he determined upon an experiment outside the domain of science. Acting upon a hint from Poppius that it was not too late even now, Berzelius suddenly proposed to his friend's daughter, the pretty Elisabet Johanna Poppius. As Berzelius was thirty years her senior, and had often adopted a bantering tone in speaking to her, Betty thought the professor was joking again—but it all ended in matrimony.

On the wedding-day, the king of Sweden—John XIV, very much of a monarch although no royal blood flowed in his veins—gave to the king of chemistry a document which created him a baron. With his marriage, there dawned for Berzelius a peace and comfort he had never known before. Unlike Wollaston and Children, Berzelius had never made much money from his discoveries, but he had enough to go honeymooning. The bridal pair journeyed through various countries, seeing many interesting things, everywhere the lusty serenades of students ringing in their ears. At Bonn, they attended the ceremonies in honor of Beethoven, and at Brühl heard a child singing—the voice of the "Swedish nightingale," soon to thrill the heart of mankind. Jenny Lind was the glory of music, but this world is full of paradox: through the influence of an English bishop she retired from the stage—and even her king's plea could not bring her back—and yet she found nothing incongruous in coming to America to place herself under the management of P. T. Barnum!

During this wedding-tour, Berzelius visited the humble farm-house where he was born, meeting some of the friends of his childhood and relatives; he had gone from Väfversunda Sörgard in his early days, an orphan despised for his poverty and disliked for his obstinacy; he returned, the greatest scientist of Sweden, with a young and charming baroness holding his arm—it reads like a scene from a Scandinavian fairy-tale.

Twelve years of domestic tranquillity remained to Berzelius. Then disease smote him, and he battled bravely, calling opium to his aid. When his spine was attacked and he found himself unable to walk, he said he would be content with the loss of his lower limbs, if only his hands and head were spared. Former pupils hovered tenderly around the paralyzed master, and all the scientific men of Stockholm considered it an honor to enter his sick-room, read to him and wait upon him. Many, like Wöhler, once entered his laboratory in awe; now, like Mosander, they left his chamber in tears. In August, his birth-month, in the year 1848, Berzelius did not wake from his sleep.

Sweden knew it had lost another Linnæus, and scientists of all countries joined in the international lamentation. The pharmacists of Germany—there was then a closer connection between pharmacy and chemistry than exists to-day—laid the laurel of a perfect tribute on the bier of the departed chemist:

> Into the immortal wreath around Berzelius' peaceful brow,
> Germany, too, gladly weaves its oaken leaves.
> For he was beloved by Mother Nature, and her manifold
> Veil she drew back before her favorite son.
> Graciously she taught him the secret of vital forces,
> Which in her blessed bosom lie concealed.
> For us he is the enlightened priest of Isis,
> For us a thousand riddles he solved,
> To us he opened wonder after wonder.
> As Moses from a barren rock enticed a stream,
> So enticed he, from stone and metal, springs of life:
> That which combines for humanity's weal,
> That which is destructive, that which can be tamed—
> This he disclosed to mortals; then, death touched him

With reluctant finger,
And returned to Mother her beloved son.
Sweden in tears interns his body,
Europa mourns him: but posterity astonished—
Admires and gives thanks.

With this unfading wreath of oak-leaves we close this sketch of a man—who rising from obscurity, engraved on plants and ores of the earth, on mountains and the moon, the name of Jöns Jakob Berzelius.

(1782–1848)

SAMUEL GUTHRIE

In August, 1831, I entered the laboratory of Yale College as Professor Silliman's assistant, and remained five years.

Professor Silliman had received from Dr. Samuel Guthrie, of Sackett's Harbor, N. Y., an ingenious self-taught manufacturing chemist, a box of his numerous products. At the beginning of the chemical course in October I opened the box, which contained chlorate of potash in larger and more beautiful crystals than any I have to this day seen, numerous varieties of percussion, waterproof priming-powder, molasses from potatoes, etc., and several bottles of chloroform distillate in alcohol (chloric ether). I believe I was the first person to repeat Guthrie's process in the course of lecture illustrations in 1831, and before the labors of Soubeiran and Liebig.

OLIVER PAYSON HUBBARD.

XV

SAMUEL GUTHRIE

If we were asked to name our favorite warrior, it would be neither the iron-lipped Wellington nor the colorful Custer—glorious on his white charger, with his yellow curls falling over his shoulders, destroying redskins—but a sober product of the Nutmeg State, Gold Selleck Silliman, soldier in the continental army and deacon of the church. Our grounds for voting for General Silliman may appear whimsical, but men have been elected president of the United States for reasons no more weighty. We like General Silliman for although a military hero by day—harassing the British in a score of encounters—when night came, instead of wrapping his martial cloak around him and sleeping in a tent guarded by armed sentinels, he went home like a good citizen. It is due to this virtue, however, that history remembers General Silliman chiefly in his night-robe.

The British commander at New York, Sir Henry Clinton, dispatched a whale boat, manned by nine Tories, to capture the colonial leader. In spite of the moonlight, the boat was hidden in the sedge of Black Rock Harbor at Fairfield, and the upholders of King George climbed two miles of Connecticut hills to the home of the sleeping patriot. On the still Sabbath morning of the first of May, 1779, between twelve and one o'clock, a rock was thrown against the door, followed by more stones and curses. Aroused from a deep slumber, Silliman seized a loaded gun from his bedside, rushed to the front window and by the light of the moon saw several armed men standing in the portico. Pushing the muzzle of the musket through a pane of glass, he pulled the trigger, but this was before the days of percussion caps, and there was nothing but a flash in the pan. We admit that at this moment, he does appear somewhat ridiculous, but we prefer him to Napoleon at Austerlitz.

Now that he was helpless, the Tories advanced with fixed bayonets and followed him into the bedroom, witnessing a scene of domesticity: the General's little son, William, ill with ague and fever, lay in one bed and in another reposed Mrs. Silliman, holding on her arm an infant, eighteen months old. Even in that extremity, the General's Yankee shrewdness did not desert him, and on the pretext of better covering his wife who was far advanced in pregnancy, he threw her dress over the sacramental silver, thus saving for his church what would have been booty for his foe.

The Silliman family forever afterwards retained a grudge against these British soldiers for their bad manners, going so far as to insist they were "rude men" and not "gentlemen soldiers"—but as proof that military etiquette has often been worse, we need only relate that three months and eight days after the midnight assault of the "ruffians," Mrs. Silliman was safely delivered of a son, Benjamin, and that after the war the whole family was reunited.

Some twenty odd years later, Yale publicly created the chair of chemistry, and the youthful Benjamin Silliman was the first professor. We emphasize that this was done openly, for Yale was founded in the colonial days and in order not to be suppressed by the Mother Country, it carried on its early activities and granted its first degrees in secrecy—prior to 1776, to study Greek and Latin in New England, it was necessary to be somewhat of a conspirator.

When Silliman sat in his new chair, chemistry was established in America. It is true, that several years before this, another Benjamin, also in his twenties, was appointed professor of chemistry in Philadelphia, but Benjamin Rush himself admitted that science was his mistress, while medicine was his wife—and thus gave Oliver Wendell Holmes the opportunity to point out that this breach of the seventh commandment was not of advantage to the legitimate owner of his affections.

In Benjamin Silliman's devotion to pure science, there was no wavering: for fifty-one years he occupied the chair of chemistry, and he finally vacated it in order to pass it on to Benjamin, Jr., who added new laurels to the name of Silliman. During the half century that the elder Silliman reigned at Yale, he was the dominant man of science in this country. By his lectures to his students, by his extra-mural talks on chemistry and physics all over the new nation, by his frequent and elaborate experiments, by his American Journal of Science—known everywhere as Silliman's Journal—he became, and remained, throughout the pre-Darwinian period, an American ambassador to the court of science.

When a meteor fell in Connecticut, Lyman Spalding appealed to Silliman for a piece; when an accident exposed a Canadian trapper's stomach to the curious eye of a physiologist, Beaumont forwarded some of the gastric juice to Silliman for analysis; when Samuel Guthrie wrote the description of a new fluid he discovered, he sent the brief manuscript to Silliman's Journal.

At eighty-five, honored by all, the Founder of Chemistry in America performed his last experiment. The story of his life was written by a Yale pedagogue in two pompous volumes. In those days, readers of "Lives" believed that George Washington could not tell a lie when a boy, and never outgrew the disability, and in keeping with biographical traditions, the departed Professor Silliman was pictured as a model of all the virtues, perfect to the point of faultlessness—and we should be grateful that the present generation does not tolerate these pious prevarications.

Silliman's biographer, who was Professor George Park Fisher—now deservedly forgotten—expects us to believe that his hero never had a selfish motive, and deems it more essential to stress his fidelity to his theological convictions than to make any reference to various investigators and truth-seekers who crossed Silliman's path throughout his long and triumphant journey. But the present generation demands of its scientists, not only that they love their wives and attend church regularly, but that they solve problems. As Silliman's numerous experiments were performed to illustrate his popular lectures and not to discover facts, his significance to-day is chronologic, not scientific. His picture in oil hangs in Yale University, but we are more curious about that backwoods chemist whose portrait does not exist anywhere, and who never achieved a biographer. It is an interesting tale, and it begins in Scotland.

The Guthries are as much a part of Scotland, as its granite. It was Squire Guthrie who brought the Wallace back to Montrose, and it was the staunch Covenanter, James Guthrie—Oliver Cromwell's "the short man that would not bow"—whose famous head is immortalized on the Martyr's Monument at Greyfriar's Churchyard at Edinburgh. Other Guthries, deciding to keep their heads, fled to America to escape religious persecution. Like wind that scatters pollen on fertile soil, in all ages religious persecution has fructified one country with refugees from another.

What Scotland lost, Massachusetts gained. In the early days of the American struggle for independence, the Guthries did their share: the Martyr's descendant, also James Guthrie, a month before Jefferson's document was autographed, signed a little Declaration of Independence of his own, and calling his sons Samuel and Joseph from their farm at Lenox, marched off to war.

"The whole country is one continued scene of blood and slaughter," wrote the anchorsmith who became one of the founders of the new nation, but the time arrived when the watchman's cry was heard throughout the land: "Past twelve o'clock, and Cornwallis is taken." The war was over, and the soldiers were farmers again.

The war's end found James' son, Samuel, practicing medicine and surgery in the Massachusetts village of Brimfield. Here were born his children Samuel, James, Rufus, Alfred, the two latter being the sons of his second marriage. He was regarded as a well-to-do village physician, and undoubtedly earned as much as the average, but his last testament proved his poverty. It is not only humiliating, but actually vulgar to mention in the most solemn of documents, such items as a dollar, five dollars, ten dollars, a watch-seal, a pair of sleeve-buttons, and a set of books. Nevertheless, with the exception of James—who became a preacher in Dayton, Ohio, and fought ferociously for the literal interpretation of every word in the Bible—all the sons of Samuel Guthrie, followed in their father's footsteps as country practitioners. But here is the will:

I, Samuel Guthrie, of Brimfield, in the County of Hampshire, and Commonwealth of Massachusetts, Physician, being weak of body but of sound mind and memory, do make and publish this my last will and testament in form and manner following, (to wit):

Firstly. It is my will and pleasure that all my just and honest debts be paid as soon as may be by my executors hereafter named.

Secondly. I give and bequeath unto my son, Samuel Guthrie, the sum of one dollar, to be paid to him by my executors hereinafter named when called for by him.

Thirdly. I give and bequeath unto James Guthrie, my son, the sum of five dollars, to be paid to him by my said executors when called for.

Fourthly. In order to prevent expense and save to my family as much property as possible, it is my will and pleasure that no part of my property be appraised.

Fifthly. All my personal property of every description whether in debts, notes, obligations, book-accounts or other property, I give and bequeath to my beloved wife, Anna Guthrie, excepting what is otherwise bequeathed. I also give and devise to my said wife, Anna Guthrie, her heirs and assigns all that messuage tract or parcel of land lying in said Brimfield, on which I now live, and all my other real estate wherever lying, to have and to hold the same to her, her heirs and assigns forever, the whole both real and personal estate to be subject to the payment of all my just and honest debts, and I hereby authorize the said executors hereafter mentioned or either of them, alone if necessary, to make sale of said real or personal estate for the payment of my said debts, and to give any proper conveyance of the same to any person or persons who may purchase the same.

Sixthly. I give and bequeath to my said son, James, before mentioned, a silver watch-seal, and a pair of silver sleeve buttons, and "Millot's Universal History," and to my son, Samuel, abovenamed, I also give and bequeath "Dr. Rush's Enquiries," in five volumes, also one set of silver catheters.

Seventhly. I give and bequeath to my son, Alfred Guthrie, one silver watch, and the Charles Gun so-called, a red morocco case of surgical instruments, and my teeth instruments.

Eightly. I give and bequeath to my son, Rufus Guthrie, a silver watch and my new gun.

Ninth. I give and bequeath to my adopted daughter, Anna Guthrie, ten dollars.

Tenth. It is my will and pleasure to appoint and I do hereby appoint Stephen Pynchon, Esq., of said Brimfield, guardian of said sons, Alfred and Rufus, and it is my desire that in all things which may tend to their happiness and to the promotion of their interest they would each of them, pay attention to his salutary admonitions and advice.

Eleventh. I constitute and appoint my said wife, Anna Guthrie, and Stephen Pynchon, Esq., sole executors of this my last will and testament, and I hereby revoke all former testaments and wills by me heretofore made.

In witness of which I have hereto set my hand and seal this sixteenth day of August in the year of our Lord eighteen hundred and eight.

Samuel Guthrie.

(seal).

Signed, sealed, published and declared by the said Samuel Guthrie, the testator, to be his last will and testament in the presence of us, who have hereunto set our names as witnesses in the presence of the testator and of each other. The interlineations on the other side being first made. To wit, in the fifth bequest.

Joseph Browning
Jonathan Morgan
Alvah Flynt

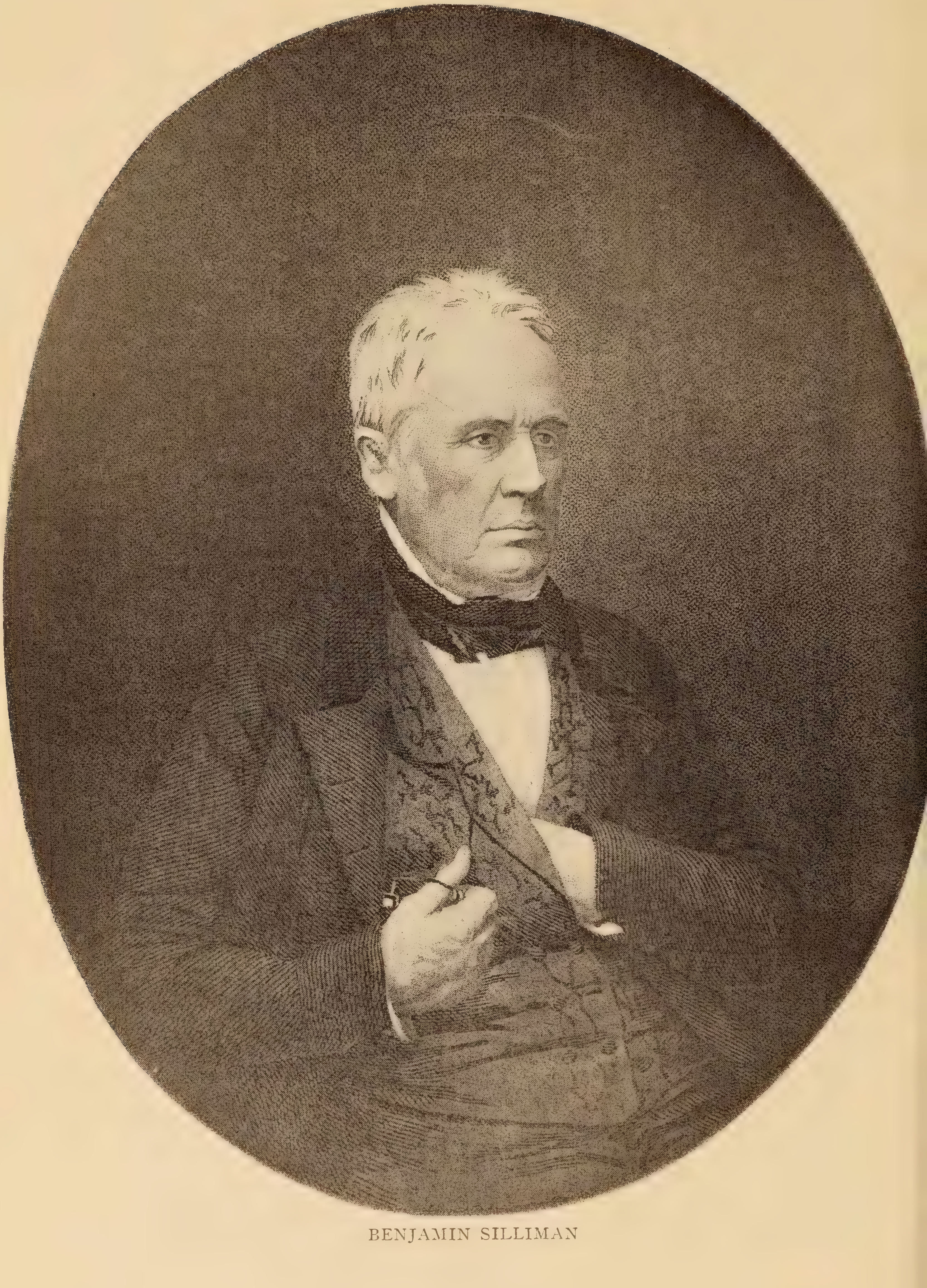
Samuel Guthrie, the younger, was twenty-six years of age in 1808, when he inherited the dollar, the catheters and the works of Benjamin Rush. Years previous, however, he had left the elm-covered home on the east side of the road of Brimfield, near Hitchcock's brook that was spanned by Guthrie's bridge. Whether his father's second marriage, or a desire for early independence caused him to bid farewell to the old homestead we do not know, and little indeed is known of the boyhood of Samuel Guthrie, Jr.

In his day there were already famous medical faculties in America—men like Benjamin Rush, John Morgan, Nathan Smith, the Warrens, the Jacksons, Valentine Mott, David Hosack, will never be surpassed as teachers or clinical observers—but medical college was regarded as a luxury beyond the dreams of many students of medicine. Thousands of youths became physicians and surgeons by entering the office of a busy practitioner. It is scornfully said to-day that they studied medicine by sweeping out the office, running the doctor's errands, polishing his instruments, and holding his horses. If this is true—and it is to some extent—it is all the more odd that these youths who never saw a sheepskin except with the sheep inside of it, should compare so favorably with highly-trained graduates of to-day. Perhaps there was more merit in the preceptor system—which actually taught medicine by cases—than we realize, or perhaps too much group diagnosis, too much reliance on case-reports taken by internes and too many laboratory aids and registered nurses, have made us clinically lazy. A century ago, many an ungainly disciple of Æsculapius took his equipment out of his much-traveled saddle-bags, entered the patient's house (chewing tobacco), spat the juice over the carpet, rolled up his sleeves over his hairy arms, sat down by the patient's bedside, and while shifting the quid to the other cheek, diagnosed the disease without syndicating it to the medical journals and prescribed effective treatment.

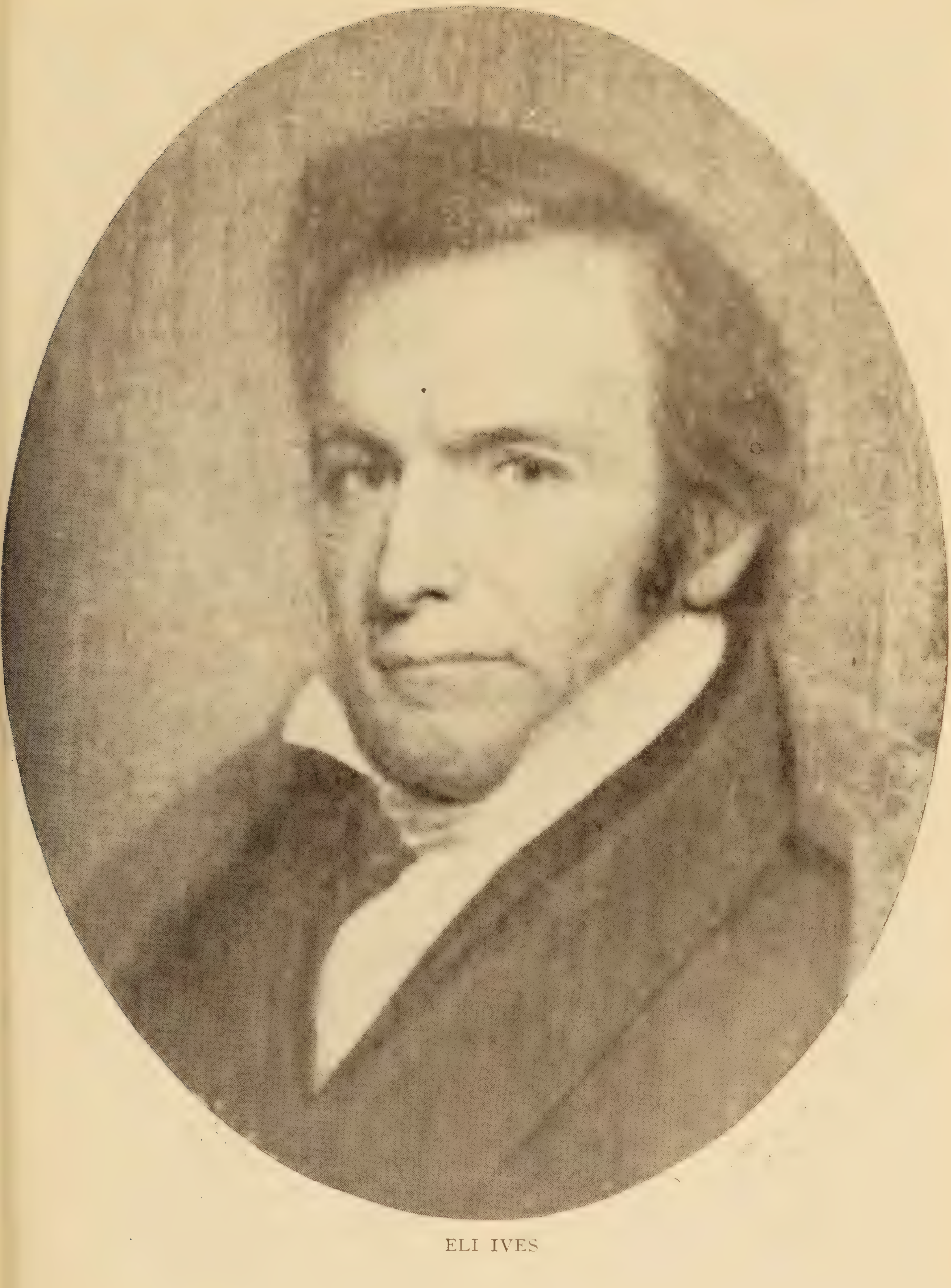
Samuel Guthrie, Jr., studied medicine with his father, and when ready to practice alone, moved to the state of New York. He settled in Sherburne, Chenango county, where his grandfather was living. His grandfather organized in his home the Second Calvinistic Congregational Society of Sherburne, and naturally young Guthrie became one of the charter members. Among others who joined the Society was Sybil Sexton, originally from Somers, Connecticut. Her father and her grandfather were revolutionary soldiers both serving in the Company of Captain Solomon Willis. Her grandmother had seventy-eight grandchildren, and reached the age of ninety-one. When Miss Sybil and Samuel Guthrie hitched up the old buggy and rode over to the neighboring village of Smyrna to be married, she was sixteen and he was twenty-two, and they had no money. Life was simpler in those days.

The chief medical event in the early years of the nineteenth century was Jennerian vaccination. Both the method and the vaccine were introduced into America by Harvard's first professor of theory and practice, the disputatious and much-disliked Benjamin Waterhouse. "That rather peculiar personage"—Oliver Wendell Holmes called him, while others employed adjectives without any qualifying adverb, and thus the career of Waterhouse illustrates that a man may be unpopular in his profession, and yet render it important service. When Benjamin Waterhouse vaccinated his own children and conducted them through a smallpox hospital with safety, the papule ceased to be the most terrible menace on the American continent.

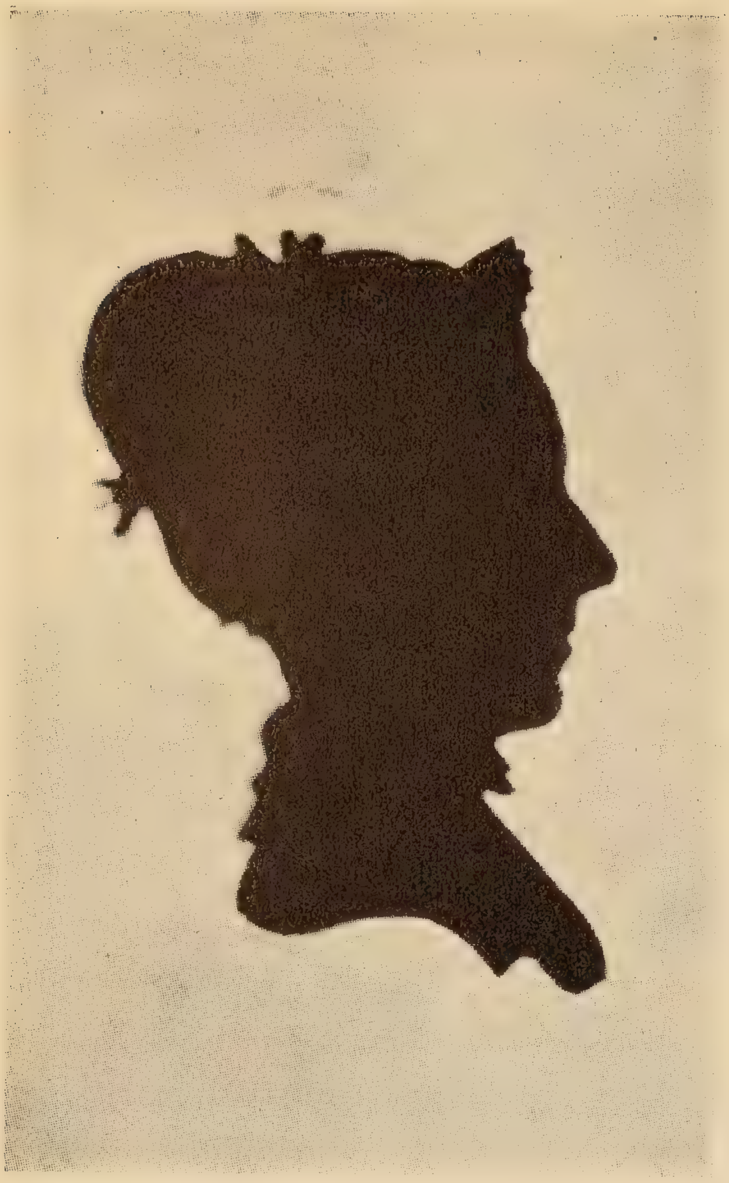
Around that period, a young doctor's first professional visit was usually to a case of smallpox. When the call came to Samuel Guthrie he responded eagerly, and in imitation of Waterhouse, he vaccinated his cousin, Sarah Guthrie, who



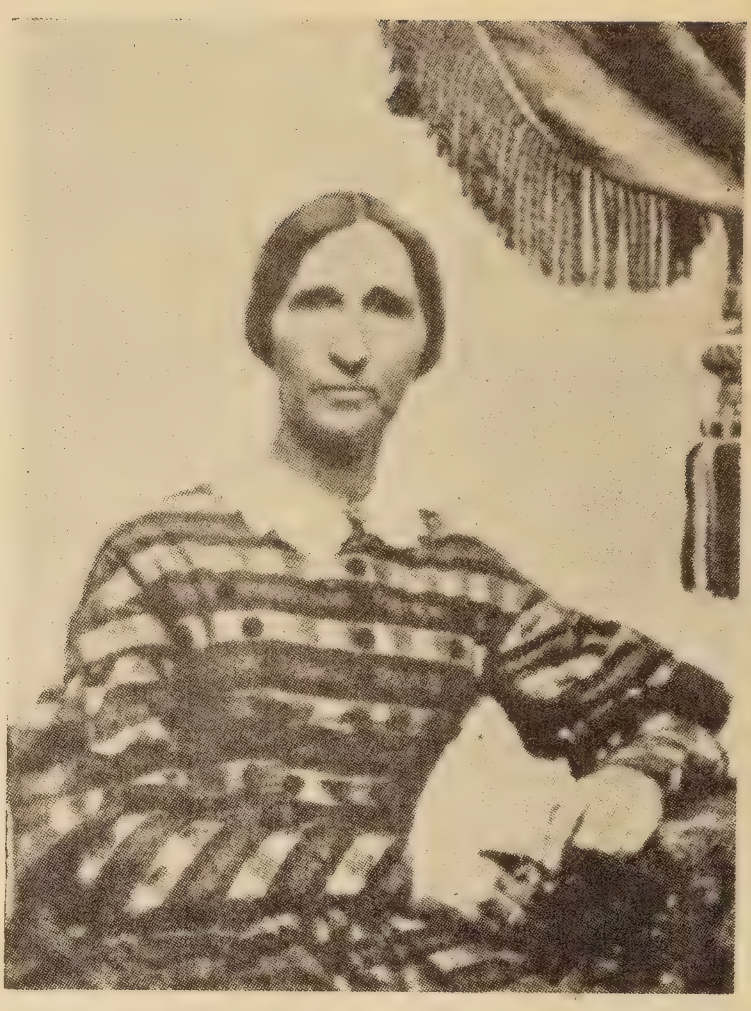
BENJAMIN SILLIMAN



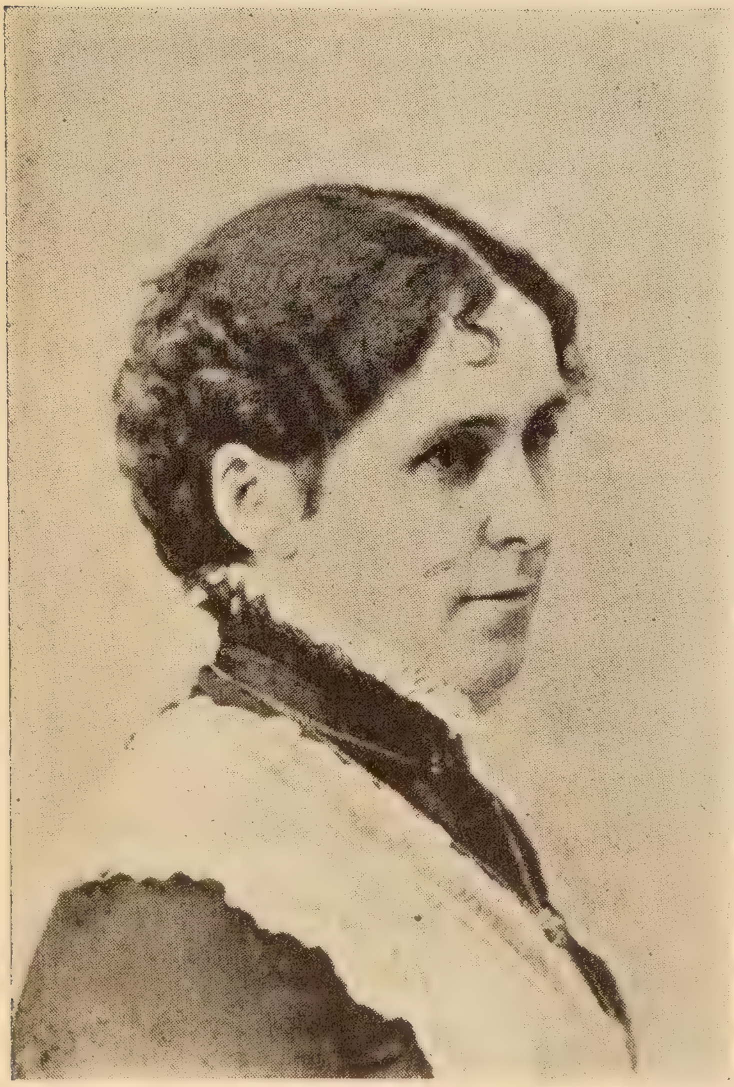
ELI IVES



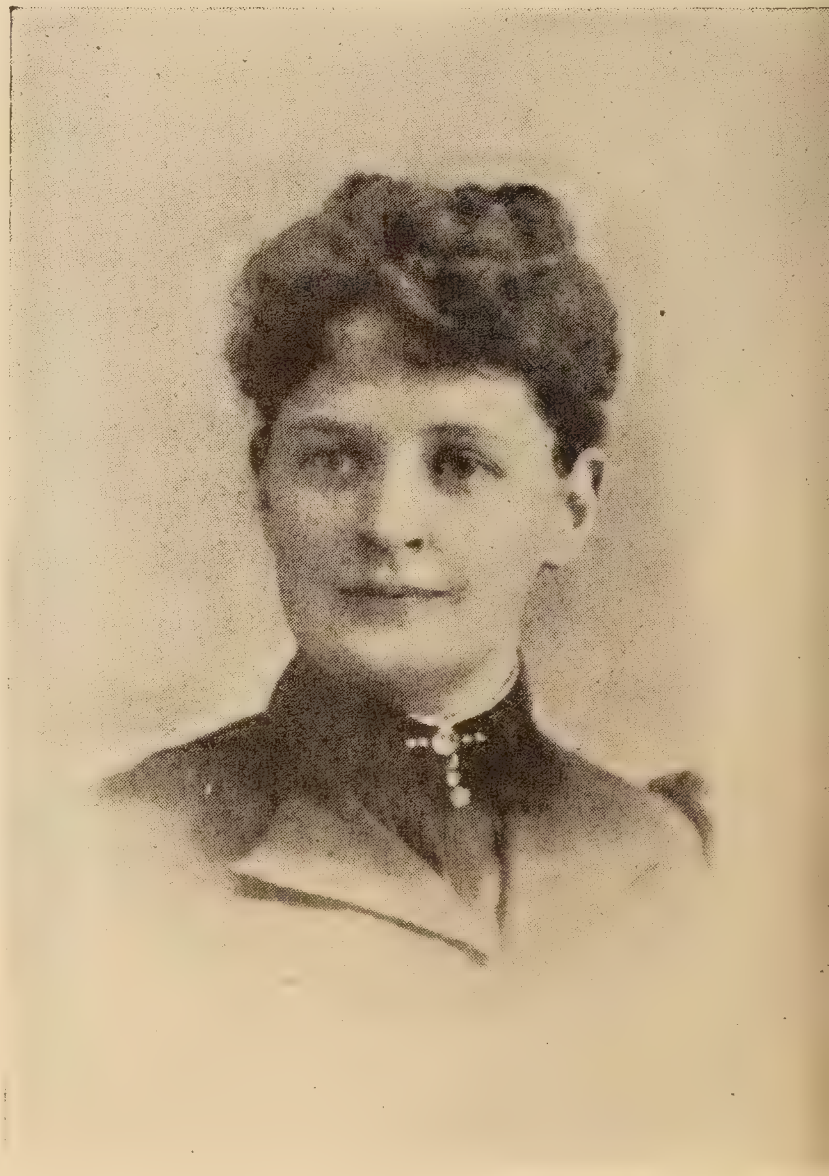
SYBIL SEXTON GUTHRIE
Wife of Samuel Guthrie.



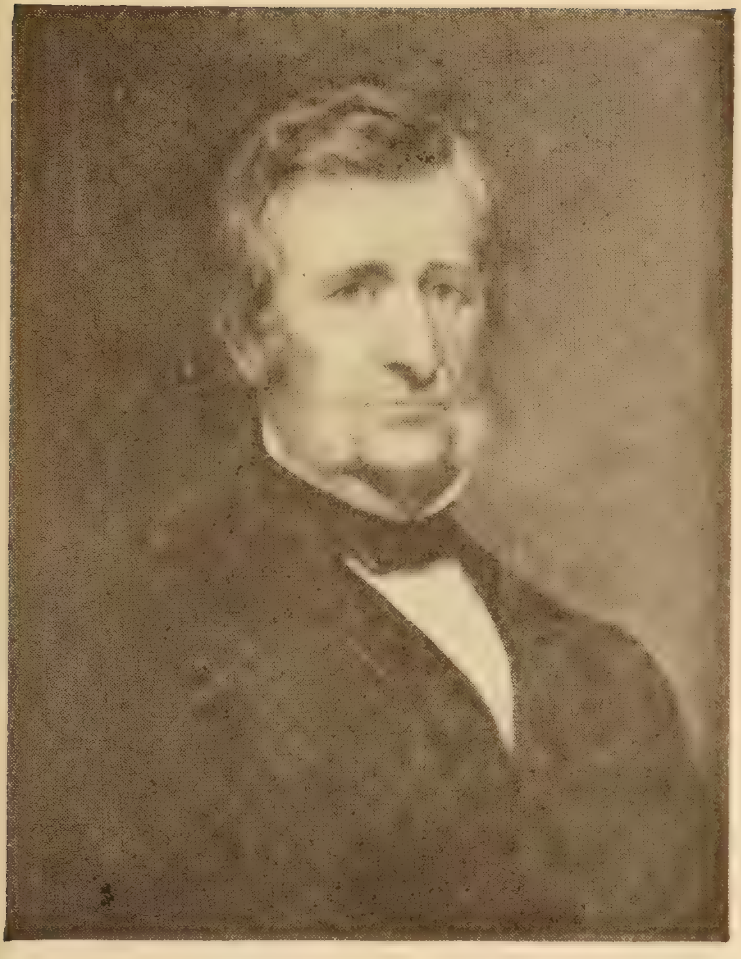
HARRIOT GUTHRIE CHAMBERLIN
Daughter of Samuel Guthrie.



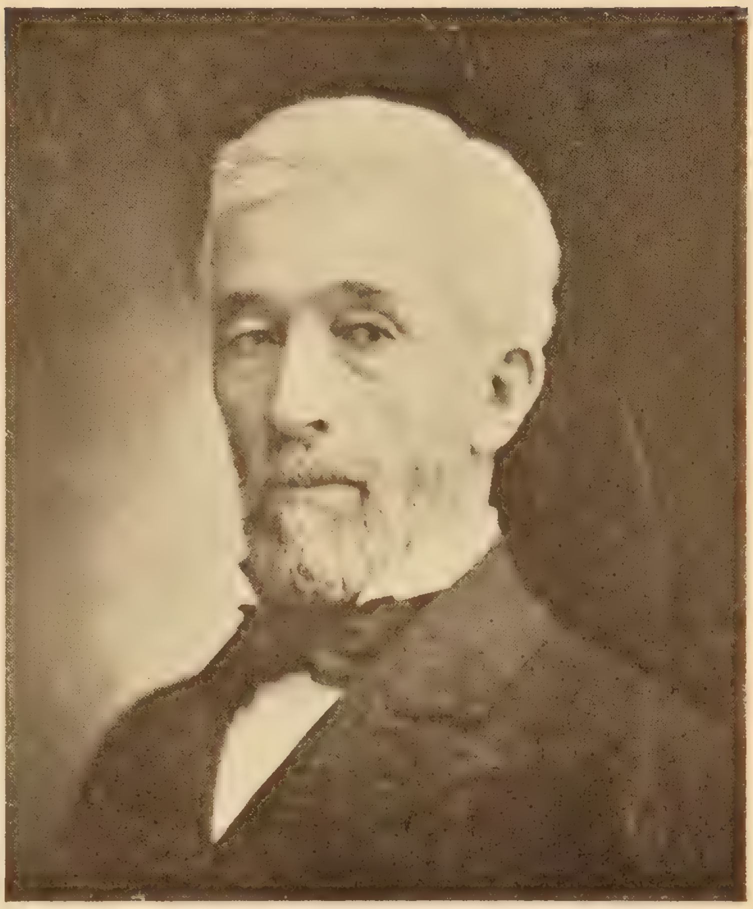
ANNA BURT DAVIES
Granddaughter of Samuel Guthrie.



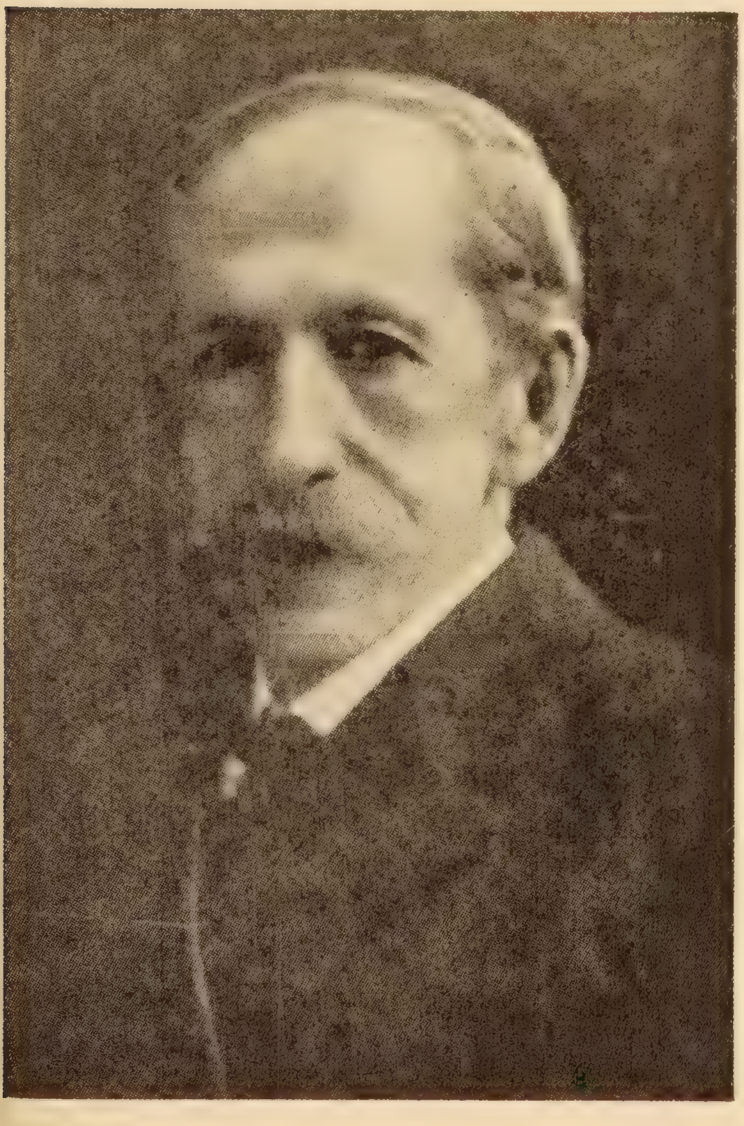
CLARISSA SIDNEY GUTHRIE BRADY
Great Granddaughter of Samuel Guthrie.



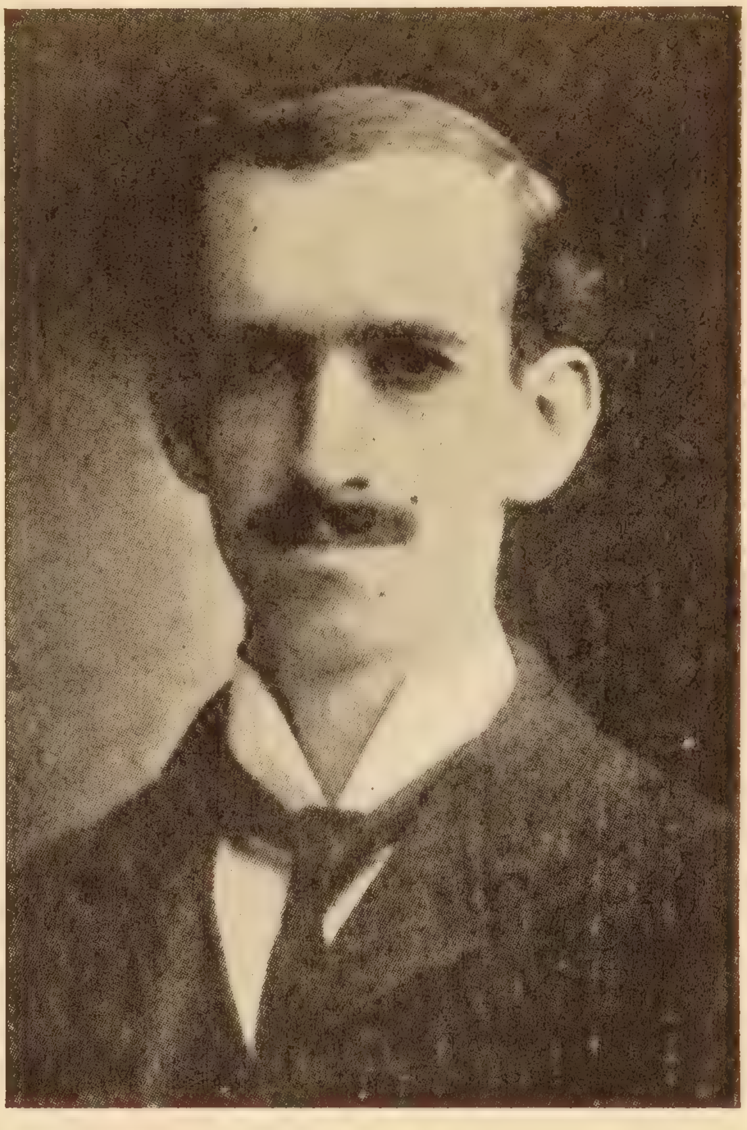
ALFRED GUTHRIE
Son of Samuel Guthrie.



OSSIAN GUTHRIE
Grandson of Samuel Guthrie



THADDEUS SAMUEL CHAMBERLIN
Grandson of Samuel Guthrie.

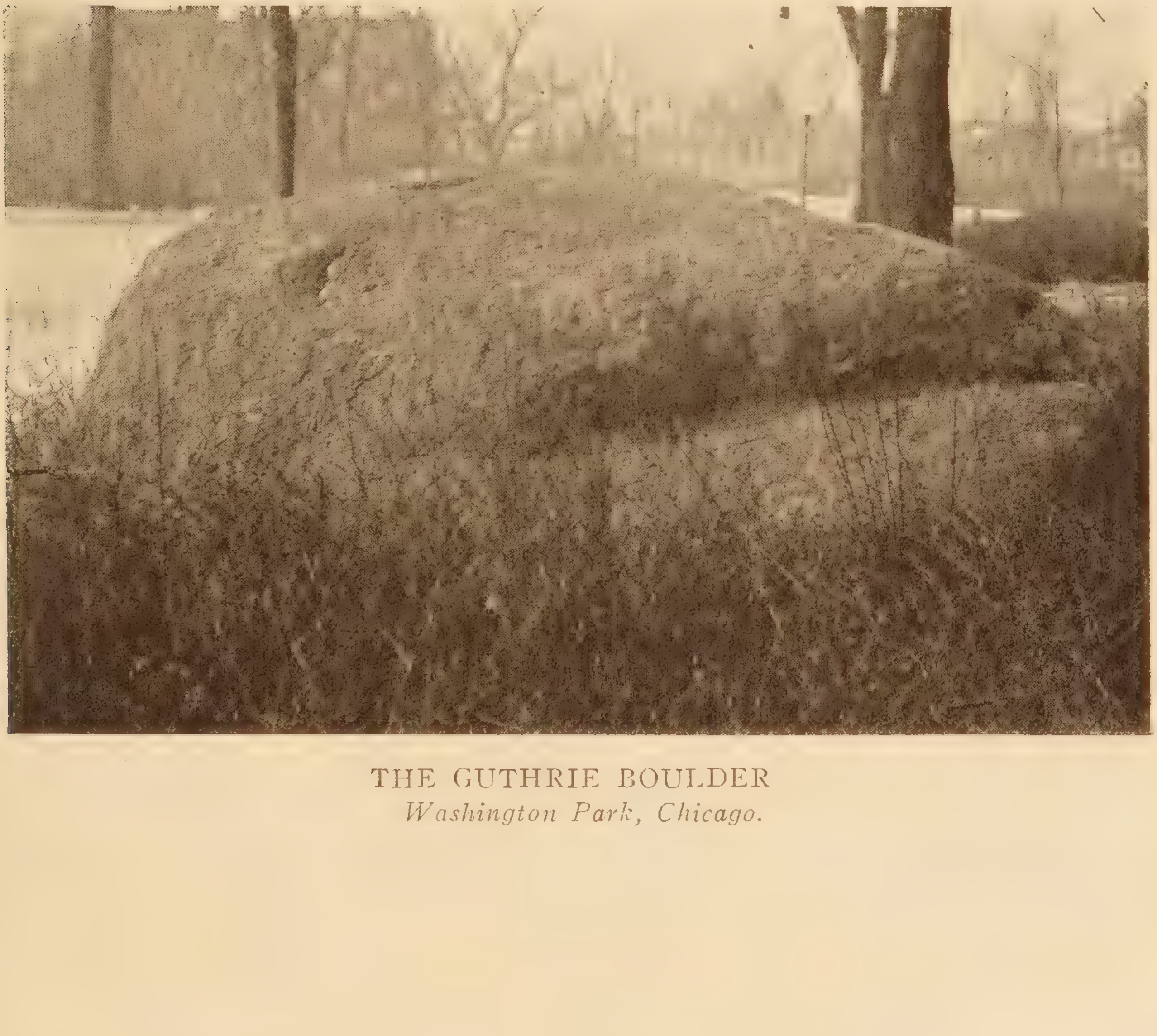


EDWIN C. CHAMBERLIN
Great Grandson of Samuel Guthrie.

BIRTHPLACE OF SAMUEL GUTHRIE
Brimfield, Massachusetts.

SACKETT'S HARBOR
New York.

HOME OF SAMUEL GUTHRIE
Sackett's Harbor, New York.



THE GUTHRIE BOULDER
Washington Park, Chicago.

had volunteered to act as nurse in the case. The bit of virus was armor against a malady that had destroyed millions, and Dr. Guthrie was launched in practice.

During the winter of 1810–11, he attended a course in the College of Physicians and Surgeons of New York, and during the month of January 1815 he listened to lectures at the University of Pennsylvania. And here his educational advantages ended. It adds to the piquancy of the picture that Samuel Guthrie was unlearned: pedants we always have with us, and science builds her altars in the laboratory rather than in the library.

Guthrie was evidently of the true pioneer breed, for after his contact with the two principal cities of America, he seems to have felt that even Chenango County was too civilized, and in 1817 he moved to the wilderness of Sackett's Harbor, Jefferson County, in the extreme north of the State of New York. Hidden a mile away was Jewettsville, on the crossroads of Mill Creek, and in these woods Guthrie was indeed the country doctor. Sackett's Harbor was young and beautiful, but already stained with human blood. The harbor was a battlefield in the War of 1812—here the British attacked the former colonists, and from this port the Americans sailed to Toronto: the British evacuated the garrison, but left some of their men to explode three hundred barrels of gunpowder in the midst of the advancing and victorious Americans, and the carnage that resulted was described in his diary by a young doctor from Connecticut who had just quit his preceptor:

> A most distressing scene ensues in the Hospital—nothing but the groans of the wounded and agonies of the dying are to be heard. The Surgeons wading in blood, cutting off arms, legs, and trepanning heads to rescue their fellow creatures from untimely deaths. To hear the poor creatures crying . . . "Do, Doctor, Doctor! Do cut off my leg, my arm, my head . . . I can't live, I can't live!" would have rent the heart of steel, and shocked the insensibility of the most hardened assassin and the cruelest savage. It

> awoke my liveliest sympathy, and I cut and slashed for 48 hours without food or sleep. My God! Who can think of the shocking scene when his fellow-creatures lie mashed and mangled in every part, with a leg, an arm, a head, or a body ground in pieces, without having his very heart pained with the acutest sensibility and his blood chill in his veins. Then, who can behold it without agonizing sympathy!

The surgeon who wrote these words never saw the inside of a medical college, but he is one of the glories of American science—William Beaumont.

Dr. Guthrie did not long continue his practice at Sackett's Harbor, for many engrossing matters soon required his full energy and attention. His lancet rusted, while pick and axe cleared the wilderness away; virgin clay from the near-by bank made a comfortable dwelling, and pure water was conducted to the new home. Gardens, orchards and vineyards spread throughout the forest; stone-walls enclosed well-cultivated fields, and barns and other buildings arose on both sides of the creek. The blacksmith shop had its forge, bellows, anvil; on the shelves were tools, spelter and borax, solder and rosin; in the corners were found sheet copper, crucibles, melting ladles, and Dr. Guthrie was the coppersmith, gunsmith and tinker.

His vinegar house was patronized by farmers' wives for miles around, and he distilled a brand of alcohol that has rarely been equaled. Up the creek was the large building where he manufactured in great quantities the Percussion Pill or priming powder which he invented. The "flash in the pan" and "picking the flint" became obsolete expressions, and Guthrie was the first man to fire a cannon by means of percussion priming powder. The tin canisters of one ounce each, labeled "Water Proof, Percussion Priming, S. Guthrie, Sacket's Harbor," became favorably known to all the sportsmen in the United States and Canada. Unnumbered woodland creatures uttered their death-cry to this powder, and hunters took off their hats to the name of Guthrie, for to kill a living thing—

be it fish or bird, or beast or man—is the keenest joy that many human beings can experience.

In the midst of the vineyards, rose a building which is not often found on the outskirts of civilization—a chemical laboratory. Odors mingled with apparatus, a dome-shaped charcoal-oven was conspicuous, and a still with its condensing worm immersed in a barrel of water was destined to make medical history.

Over this demesne, with firmness yet kindliness, Dr. Guthrie presided. Here his children—Alfred, born in 1805; Edwin, in 1806; Harriot, in 1810; and Cynthia, in 1823—found their real home. Grandchildren came, grew up in Sackett's Harbor, ate the fruit of his orchards, and romped in his workshops and ventured in his laboratory. The Doctor was a busy man, but sometimes he went hunting and fishing, took part in a game of whist, or played his violin. Now and then he visited the growing metropolis on the Hudson, was jostled by the crowds on Broadway-in-the-making, and returned home with interesting news—on one occasion telling his family that a man named Morse, who had studied electricity at Yale under Silliman, had just invented the telegraph.

Guthrie's reading was not confined to the Bible, as was often the rule in those days. He had Shakespeare, Don Quixote, Gil Blas, and Rasselas in his library; he consulted the Edinburgh Encyclopedia, and subscribed to the standard medical and chemical works. When he was about fifty, Dr. Guthrie himself became an author, sending six contributions to the American Journal of Science, in the form of letters to the editor.

He informed Benjamin Silliman of his experiments on the vaporization of mercury in the fumes of nitric ether, on making sugar from potato starch (July 1831), on fulminating preparations, purification of oil of turpentine, and a new process for manufacturing gunpowder (September 12, 1831).

From the latter communication, we quote characteristic passages that illustrate some of the dangers of pioneer chemistry:

With this preparation (nitrated sulphuret of potash), I have had much to do, and I doubt whether, in the whole circle of experimental philosophy, many cases can be found involving dangers more appalling, or more difficult to be overcome, than melting fulminating powder and saving the product, and reducing the process to a business operation. I have had with it some eight or ten tremendous explosions, and in one of them I received, full in my face and eyes the flame of a quarter of a pound of the composition, just as it had become thoroughly melted. . . .

Since writing my article on starch sugar, I perceive in Gray's Operative Chemist, a direction that the wooden converter should be lined with lead. This is wrong—in the first place, it is entirely unnecessary, as the acid so much diluted does not act on wood. In the second place, either the acid or the syrup or both will act upon the lead and poison the product.

You have told me to write freely, and I trust you will not complain of the length of this communication. Nor must you complain against the fulminating character of my letters; for I have lived for many years in the midst of explosions, and even whilst writing this letter, I have been interrupted by the noise of a heavy explosion, followed by the shrill scream of "fire" from my alcohol distillery. The history of the accidents, effects of explosion, danger, escapes, and contrivances growing out of my yellow powder business would fill a volume; and with the percussion powder which I now make I have had probably one hundred explosions more or less severe. Thirty pounds of the powder is the largest quantity I have had burned at one time; but the most distressing accident I have encountered, scarcely excepting the severe burn which I sustained from yellow powder, arose from putting my hand into a keg containing about four pounds of percussion powder, and cracking a piece of it between my thumb and finger, by which it took fire; roasting my hand and arm, and tearing off most of the skin of my breast, neck, and face. But enough of this. I am now making two hundred pounds of the chlorate of potash, and when I get through, I shall be able to estimate the comparative value of carbonate and caustic potash in making this salt.

With great respect, your obedient servant,
SAMUEL GUTHRIE.

Professor Silliman was surprised and pleased to find such chemical sagacity at Sackett's Harbor, and he inserted several complimentary notices about Samuel Guthrie. For example: "Mr. Guthrie's preparations have all arrived, and although I reserve the trial of most of them, to my winter course of experiments, I am impressed with admiration both at his skill and intrepidity.—Ed." "I add a notice of the following facts, communicated by Mr. Guthrie in his letters, not for publication, but which I conceive are honorable to the rising chemical arts of this country. I presume it was little suspected that such things were doing in a remote region on the shore of Lake Ontario.—Ed."

In 1830 appeared the second volume of Silliman's Elements of Chemistry; on page 20 occurs this paragraph about chloric ether:

> (*h*) *Properties.*—Resembles an oil, color yellowish, but white, when purified; sinks in water in distinct globules, which readily run together. Sp. gr. at 45° 1.22. By much agitation, is diffused in the water, and partially dissolved, imparting to the water its own peculiar taste, which is sweetish, aromatic and agreeable. Taken internally, it is stimulating and reviving. For this purpose, it is dissolved in alcohol, which happens instantly by agitation in a vial, and the alcohol can then be diluted to any desired degree. Its medicinal powers have not been ascertained, but from its constitution and properties, it is highly probable that it would be an active diffusive stimulant.

Many skipped this passage, some read it, few remembered it, but Guthrie took it to his laboratory, and before putting the book on the shelf, he sent Silliman a brief and undated letter. Under the title of "New mode of preparing a spirituous solution of Chloric Ether," this letter was published on the lower half of page 64, and upper half of page 65 of number 1 of volume xxi of Silliman's Journal (1831), with Remarks by the editor:

> Art. VI.—*New Mode of preparing a spirituous solution of Chloric Ether; by* Samuel Guthrie, of Sackett's Harbor, N. Y.

Mr. Editor—As the usual process for obtaining chloric ether for solution in alcohol is both troublesome and expensive, and as from its lively and invigorating effects it may become an article of some value in the *Materia Medica,* I have thought a portion of your readers might be gratified with the communication of a cheap and easy process for preparing it. I have therefore given one below, combining these advantages with unerring certainty in the result.

Into a clean copper still, put three pounds of chloride of lime and two gallons of well flavored alcohol, of sp. gr. .844, and distil. Watch the process, and when the product ceases to come highly sweet and aromatic, remove and cork it up closely in glass vessels. The remainder of the spirit should be distilled off for a new operation. These proportions are not essential—if more chloride of lime be used, the etherial product will be increased; nor is it necessary that the proof of the spirit should be very high, but I have commonly used the above proportions and proof, and have every reason to be satisfied with them. From the above quantity I have usually obtained about one gallon of etherial spirit. The affinity of chlorine to lime, is so weak, and to alcohol so strong, that the chlorine is all taken up, long before the distillation is over; hence, the absolute necessity of watching the process, so as to know when to set aside the etherial portion.

By re-distilling the product from a great excess of chloride of lime, in a glass retort, in a water bath, a greatly concentrated solution will be obtained. This new product is caustic, and intensely sweet and aromatic. By distilling solution of chloric ether from carbonate of potash, the product is concentrated and refined. By distilling it from caustic potash, the ether is decomposed, and muriate of potash is thrown down, while the distilled product consists of alcohol.

During the last six months, a great number of persons have drunk of the solution of chloric ether in my laboratory, not only very freely but frequently to the point of intoxication; and so far as I have observed, it has appeared to be singularly grateful, both to the palate and stomach, producing promptly a lively flow of animal spirits, and consequent loquacity; and leaving, after its operation, little of that depression consequent to the use of ardent spirits. This free use of the article has been permitted, in order to ascertain the effect of it in full doses on the healthy subject; and thus to discover, as far as such trials would do, its probable value as a medicine. From the *invariably* agreeable effects of it on persons in health and the deliciousness of its flavor, it would seem to promise much as a remedy in cases requiring a safe, quick, energetic, and palatable stimulus. For drinking, it requires an equal bulk of water.

Remarks.—Mr. Guthrie states in a letter to the editor, that his attention was called to this subject by the suggestion in Vol. II. p. 20, of the Yale College Elements of Chemistry, that the alcoholic solution of the chloric ether is a grateful diffusive stimulant, and that as it admits of any degree of dilution, it may probably be introduced into medicine. Mr. Guthrie's method of preparing it is ingenious, economical and original, and the etherized spirit which he has forwarded as a sample, is exactly analogous, in sensible properties to the solution made in the manner described in the above work. We shall take care to distribute portions among our medical friends for experiment, and as chlorine possesses so many peculiar powers, it is not impossible that this combination may prove curative or restorative, beyond what belongs to properties merely stimulating.

In this latter respect, Mr. Guthrie's experiments have certainly been *quite sufficient;* and we ought to discountenance any other than a medical use of this singular solution; unless indeed it should be found of utility in some of the arts. He would be no benefactor to his species who should add a new attraction to intoxicating spirit.—EDITOR [Benjamin Silliman]

Little did the writer suspect that with these five hundred words he has made immortal the name of Samuel Guthrie. He thought he had devised an easier and cheaper way of preparing chloric ether, or what was long known as the Oil of Dutch Chemists, but in reality he had discovered, in purity and strength and sufficient quantity, one of the most remarkable of fluids—chloroform. If instead of fearing that the new method might introduce a new intoxicating beverage, Silliman had realized that it could produce insensibility to pain, anesthesia would have had an earlier history.

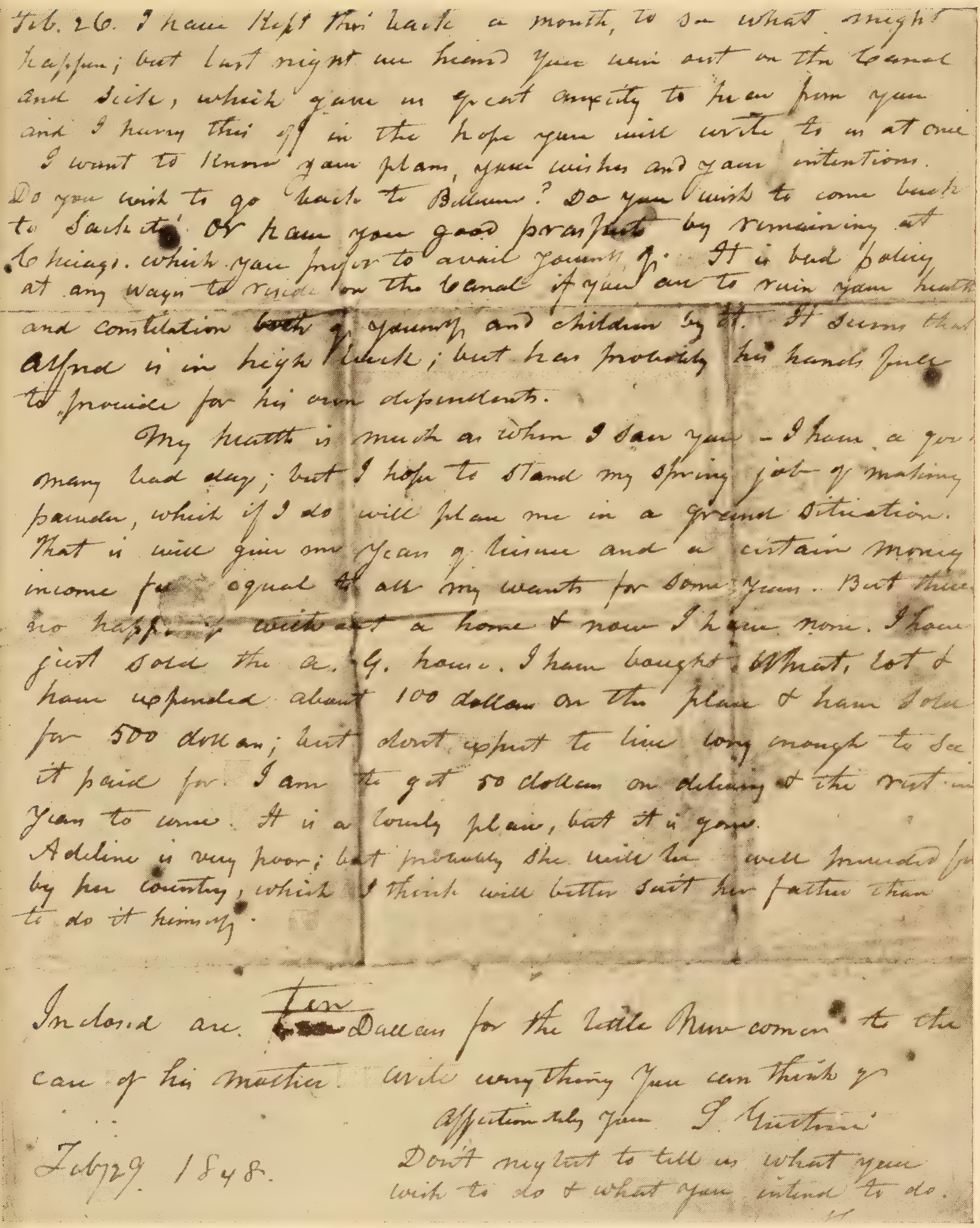
Guthrie's failure to date his chloroform communication, has resulted in reams of controversy, for at about the same time that chloroform was made by Guthrie in America, it was discovered by Soubeiran in France, and by Liebig in Germany —and nitrous oxide and ether and chloroform have ever been fertile soil for argumentative skirmishes over priority. The facts in the case are these: Soubeiran's first article on chloroform was written for the October 1831 issue of Annales de Chimie et de Physique, but as France was having a little revolution at that time, the delayed periodical published the complete meteorological report for October and did not appear until January 1832; Liebig's initial contribution was a mere note in Poggendorff's Annalen, under date of November 1831; Guthrie's letter is in Silliman's quarterly for October 1831 (which made its appearance in January 1832) and although Guthrie's article is undated, subsequent contributions bear the date of July 1831—which indicates that his chloroform article was written prior to that month and his manuscript reached the printer before Soubeiran's or Liebig's.

Another important factor is that Guthrie, Soubeiran, Liebig, discovered chloroform, each independently of the other, at practically the same time—as has happened so often in science—and science never insists that her laurels be confined to a single brow.

Silliman gave several samples of Guthrie's fluid—Guthrie's sweet whisky it was then called—to some of his medical friends, especially to Eli Ives, for clinical tests. In the appendix to volume xxi, appear the reports of Eli Ives, and of his son, Nathan B. Ives, with remarks by Silliman. As this is the first time that chloroform was discussed therapeutically, we quote the appendix in full:

Dear Sir—I have witnessed the effect of the chloric ether, with which you were so kind as to furnish me, and in some other instances where you had furnished individuals who wished to try its effect.

I have given it to a female, 60 years of age, who had been



Feb. 26. I have kept this back a month, to see what might happen; but last night we heard you were out on the Canal and sick, which gave us great anxiety to hear from you and I hurry this off in the hope you will write to us at once. I want to know your plans, your wishes and your intentions. Do you wish to go back to Bellevue? Do you wish to come back to Sackets? Or have you good prospects by remaining at Chicago which you prefer to avail yourself of? It is bad policy at any wages to reside on the Canal if you are to ruin your health and constitution ~~both~~ of yourself and children by it. It seems that Alfred is in high luck; but has probably his hands full to provide for his own dependents.

My health is much as when I saw you - I have a great many bad days; but I hope to stand my spring job of making powder, which if I do will place me in a grand situation. That is will give me years of leisure and a certain money income far equal to all my wants for some years. But there's no happiness without a home & now I have none. I have just sold the A. G. house. I have bought Wheat's lot & have expended about 100 dollars on the place & have sold for 500 dollars; but don't expect to live long enough to see it paid for. I am to get 50 dollars on delivery & the rest in years to come. It is a lovely place, but it is gone.
Adeline is very poor; but probably she will be well provided for by her country, which I think will better suit her father than to do it himself.

Inclosed are Ten ~~[illegible]~~ Dollars for the little new comer to the care of his mother. Write everything you can think of

Affectionately yours S. Guthrie

Feby 29. 1848.

Don't neglect to tell us what you wish to do & what you intend to do.

HANDWRITING OF SAMUEL GUTHRIE

Last page of the "chloroform letter," written to his daughter, Harriot Guthrie Chamberlin, mother of Thaddeus Samuel Chamberlin.

subject to severe paroxysms of pain in the chest and difficulty of breathing, called asthma. The paroxysm, for which I gave the chloric ether, was thought more severe than any she had had before; she took the remedies, as she had ordinarily taken them, previous to the use of the chloric ether, without very obvious effect. The chloric ether was given in doses of half a tea-spoon full, once in two hours, for twelve hours. It was given in the course of the night, and in the morning the patient was very much relieved, more suddenly than she had been in any previous illness of the kind. The patient and the friends attributed the speedy and effectual relief to the chloric ether. It appeared to me that the ether was the efficient article that had produced the relief.

Mr. D. W. with pulmonic disease, has inhaled the chloric ether to obviate general debility and difficult respiration. The article has been effectual to obviate those symptoms, its immediate effect beside giving relief, is that of giving a pleasant sensation.

I have given the chloric ether to children in the ulcerated sore throat. A child of Mr. P. was attacked with ulcerated sore throat, (called scarlet fever; Rosalia of Dr. Good,) this child died on the fifth day. This child took no chloric ether, indeed, it was so deranged that it was difficult to administer any medicines. A brother of the same child attacked with similar disease, had deep ulcers in the throat, and high fever with derangement. The chloric ether was given every two hours in doses of thirty drops, diluted with an ounce of water; the child was at all times ready to take this medicine, and it was continued until the fever abated. The child began to mend after the fifth day. The ether was thought to allay the irritation in the nervous system, abate the heat of the skin, and to have a good effect upon the ulcers in the throat.

This patient recovered very rapidly.

I have given the chloric ether in several other cases of scarlet fever, in cases of adults, giving it in doses of a tea-spoon full, diluted with water. I have been pleased with the operation of this ether, it is diffusible in its action like the other ethers, it possesses the peculiar properties of chlorine, and it has this advantage over the sulphuric or other ethers, that it is always grateful. I have known no child refuse it.

Yours, etc.

January 2, 1832 E. Ives.

N. B. The last vial you furnished me, I gave to a female, fifty years of age, who has been affected with paroxysms of asthma for more than twenty years. I have seen the patient but once since the medicine was given, when she was evidently better, and said she thought the medicine had done her good. I have used the ether for spasmodic cough, and am so much satisfied with the beneficial effects of the remedy in such cases, that I shall use it more extensively as soon as I shall be able to furnish myself with a quantity of it.

E. I.

Dear Sir—I have been much pleased with the effects of the "chloric ether" with which I was favored through your kindness. The first case in which I administered it was in that of Mr. Coffing, who was severely ill with atonic quinsey—he was unable to swallow. The ether was injected by means of a syringe, with the happiest effect. After using the syringe he was able to swallow and took the same article internally with benefit. I have also witnessed its beneficial effects in pneumonic cases.

Nathan B. Ives.

I have not yet received the statements of the other medical gentlemen, but have understood that the chloric ether has generally proved grateful, soothing and reviving, and the patients have sent to me repeatedly for a renewal of their supply, as the ether is not to be obtained in the shops. It appears to have been particularly acceptable in various maladies induced by the prevailing influenza. Having been requested, by some of our physicians, to obtain a supply for regular use I have written to Mr. Guthrie, and received from him an answer dated Sackett's Harbor, Dec. 24, 1831, from which the following is an extract:

"I have been confined by sickness most of the time since the 7th of October, but am now recovering rapidly, and hope within a very few days to be able to go into my laboratory, when I shall prepare, and forward to the care of Van Buren, Wardell & Co., New York, the chloric ether you advised me to send, and they will immediately forward it to the gentleman you designated. The price of the chloric ether, you must be aware, will form no objection to its general use as a medicine." Mr. Guthrie even names a price at which it may probably be afforded, and although it might be premature to mention it now, I may remark, that it is very low. Mr. Guthrie, or his agents in New York, will supply the chloric ether in any quantity, and send it in any direction. As regards the moral effect of using chloric ether as a medicine, there is no more danger than from other medicines of which alcohol is the vehicle. Some highly respectable physicians, it is true, are of the opinion that no such preparations should be used medicinally, but this appears not to be the general opinion of the faculty.

At present, no other vehicle than alcohol is known by which chloric ether can be rendered manageable; in alcoholic solution it may be given, either in small doses, or freely, if largely diluted with water.

Remark.—As no accurate examination has been made in point of theory, we cannot say precisely what takes place during the distillation of alcohol from chloride of lime. It is, however, worthy of notice that, as alcohol is believed to be composed of olefiant gas and water, (or at least of elements in such relative equivalents that they may admit of being so assorted) and as ether has a similar constitution, although in a different ratio of the equivalents, and as chloric ether has been heretofore produced by the combination of chlorine and olefiant gas, it seems hardly to admit of a doubt, that in distilling alcohol from chloride of lime, the latter gives its chlorine to the olefiant gas of a part of the former, and thus produces chloric ether which passes over, in solution, in another portion of the alcohol, while the water of that portion of the alcohol which afforded the olefiant gas, or the water which may be supposed to be produced by a combination of the elements, is detained by the lime.

Yale College, January 6, 1832.

Can any method be devised by which the alcohol can be detached from the chloric ether, and the latter obtained concentrated and in quantity?

—EDITOR [Benjamin Silliman]

Eli Ives was a man of note in his day. He was born the same year as Silliman, also in Connecticut, where his father, Levi Ives, was one of the leading practitioners of New Haven, and a founder of the New Haven Medical Society. His educational advantages were excellent. He was graduated from Yale

College, his father and the famous clergyman-physician, Eneas Munson, were his preceptors, and at the University of Pennsylvania, he studied under the men who laid the cornerstone of American medicine: Rush, Wistar and Barton. Time and chance frequently placed the name of Eli Ives in the introductory chapter of new ventures: when the Yale Medical School was being founded, Ives was on all the committees; when the School was opened he was the first professor of materia medica; when Lyman Spalding issued the call for the first convention of the United States Pharmacopœia, Ives was the delegate from Connecticut; when the American Medical Association met for the first time in New Haven, Ives was chosen president; when chloroform was discovered in America, the first bottle for experimental purposes was put into the hands of Eli Ives. Destiny, in the shape of Guthrie and Silliman, gave Ives an opportunity to be a pathfinder—but he remained Professor of the Theory and Practice of Medicine in the Medical Institution of Yale College. It was not in the land of its discovery that chloroform revealed its secret.

Many others besides Ives, however, came near the truth without guessing the riddle. As early as July 1832 Daniel Smith—one of the principal founders of the Philadelphia College of Pharmacy and of its journal—wrote: "The action of this ether on the living system is interesting and may hereafter render it an object of importance in commerce. Its flavor is delicious, and its intoxicating qualities equal to or surpassing those of alcohol. It is a strong diffusible stimulus similar to the hydrated ether but more grateful to the taste." In the following year, 1833, Black of Bolton, England, recommended it in spasmodic asthma, and spoke of it as a new remedy "brought into use by our American brethren." In 1834, Dumas analyzed it, showed that Soubeiran's solution was impure and Liebig's formula incorrect, and the great French chemist gave to the young fluid the baptismal name by which it has since been known—chloroform.

This thick limpid liquid lay in Guthrie's vats; his children and grandchildren dipped in their fingers and tasted of its peculiar sweetness: he gave it to his daughter Harriot in her illness; his grandson Ossian, stated in his memoirs that "the writer in his childhood, had free access to Dr. Guthrie's laboratory, where he was frequently attracted by the agreeable and never-to-be forgotten odor of chloroform." The following letter from his granddaughter, written to her cousin Thaddeus Samuel Chamberlin, is now published for the first time:

> Grandfather used to let my mother play in his laboratory when he was experimenting. He had large tubs of liquid standing on the floor and she used to stick her fingers in the tub and taste the liquid, one tub she liked to taste, so did often, and he was watching her and one day she got too much and fell over and he ran to her and picked her up and then found that the liquid in this tub put her to sleep, hence his accidental discovery what chloroform would do. She was about eight years old at that time.
>
> HATTIE [GRIFFIN].

But even with this hint in his hands, Guthrie did not realize that he had discovered the waters of the modern Lethe.

The years passed, but they were not years of tranquillity for the patriarch up at Sackett's Harbor. Usually the encroaching railroad increased the wealth of a section, but in the north country commerce left the lake shore to follow the iron horse. The prosperity of Sackett's Harbor passed, and Dr. Guthrie's fortune declined. Yet, although Ossian thought to the contrary, he was able to leave to his children and grandchildren, thousands of dollars, village lots along Black River Bay of Sackett's Harbor, and tracts of lands in Iowa and Indiana.

Not all his children, alas, were there to inherit. The western fever swept through the country, and the restless Guthrie blood responded. Then along our southern frontier was heard the stirring call of a bugle—and behind it was the slave power of

America, bullying Mexico into conflict, in order in the name of Freedom, to annex more territory for the extension of human slavery. "For myself," wrote one of the participants, "I was bitterly opposed to the measure, and to this day regard the war, which resulted, as one of the most unjust ever waged by a stronger against a weaker nation. It was an instance of a republic following the bad example of European monarchies, in not considering justice in their desire to acquire additional territory." An awful historical indictment—these words of U. S. Grant!

It was not much of a war, and the last scene was like the climax of a play, when the commander of the Army of Invasion, General Winfield Scott, a man of magnificent physique, reined up his horse at the Grand Plaza of the Mexican capitol, removed his hat with a dramatic gesture, and announced the conquest of Mexico. In the meantime, however, much precious blood had been spilled between the prairie grass and the Gulf. After the battle of Buena Vista, a young Kentuckian, Henry Clay, son of the statesman, lying wounded upon the ground, was killed by a nameless Mexican. Samuel Guthrie's son, Edwin, read the war-odes in the American newspapers, and decided he must whip Mexico. His brother Alfred tried to dissuade him from joining the volunteers by calling his attention to the fate of Captain John Page, who in the opening battle of Palo Alto, lost his life when his under jaw was shot away. But the ardent Edwin was commissioned Captain of Company K in the Fifteenth United States Infantry, and came down from Iowa to Mexico. Through the palmettos a guerrilla's bullet struck him in the knee; two amputations could not save him, and his last act was to sign his name to these notes which he dictated:

> Well, Brother Alfred, I have indeed met the fate of Page. I have been wounded, and am to die in the Castle of Perote—. A few hours closes my earthly career.
>
> Edwin Guthrie.

My Dearly Beloved Sister: The physicians have been in this evening and told me there is no earthly hope, a few hours closes my life on this earth. Accept a brother's dying love.

EDWIN GUTHRIE.

His widow, Adaline Jewett Guthrie, was the daughter of the founder of Jewettsville; Guthrie County, Iowa, was named in honor of Edwin Guthrie. The son of the man who discovered chloroform, suffered and perished without anesthesia. Fifteen years later, during the War of Secession, over one million and a half of pounds of chloroform were used.

Alfred, the eldest of Samuel Guthrie's children, drafted the United States Steamboat Law, with its life-saving system, and designed the Hydraulic Works of the Illinois and Michigan Canal, which was capable of raising such an enormous quantity of water that it was regarded as one of the chief engineering feats of the time. He had eight children, among them being Ossian, the untaught but expert practical geologist, whose life-work was to drain the city of Chicago and clarify the river. He became known as the Father of the Chicago Drainage Canal. The mechanical ingenuity of Samuel Guthrie, of his son Alfred, and of his grandson Ossian, is an interesting item to students of heredity. With Ossian, however, the story ends, for although he married Martha Betts of Saratoga County, New York; then Lois R. Osgood, of Blue Hill, Maine; then Eunice Hoxie, of North Fairfield, Maine; then Mrs. Lucy Adams Stebbins, of Adams, New York, all his offspring—two boys and two girls—died in infancy.

It is strange that after 1831–32, in spite of the cordial encouragement of the famous Silliman, and although sixteen years of activity remained to him, Samuel Guthrie never published another contribution in the American Journal of Science or in any other periodical.

In the evening of Guthrie's life, the medical world rang with a new name. A Scotchman who remained in Edinburgh had risen to greatness on the fumes of chloroform. James Young

Simpson uncorked a bottle of the heavy fluid, and at the same time opened a new era in anesthesia. The power of chloroform to conquer pain, assuaging the pangs of parturition, spreading the blessed mantle of oblivion over operative tortures, was finally revealed.

Shortly afterwards, Guthrie wrote one of his last letters—full of interest and pathos. He had enough money—"But there is no happiness without a home and now I have none." It is addressed to his elder daughter, Harriot, and although nearly eighty years have elapsed since it was written, it is now published in its entirety for the first time. To make its reading easier, we have paragraphed it, and have italicized that portion which causes it to be known among his descendants as the "chloroform letter":

February 1, 1848.

Dear Harriot, I am sitting in Cynthia's sitting room at 10 o'clock at night and all quiet and abed and as it is some time since I wrote to you I cannot enjoy an hour or two better than by talking with you. Since we have had any conference the painful intelligence of the death of our beloved Edwin has been most fully confirmed. This is a sad blow and I feel it most painfully. He wrote to me just as he was dying and says "Father! I have come all the way to Mexico to be shot: my physicians tell me I have but a few hours to live and I die deploring that I have robbed you all my life." Oh! poor fellow! how much agony he endured. I have no doubt he gladly embraced death to fly from his sufferings.

Edwin's private affairs were in a dreadful situation and a knowledge of it must have given him great pain. I doubt if I save anything from the wreck. I would gladly lose the $1,500 I gave him for the favors if I could get free from it. Thurstin says he was $4,000 bad. You have seen Col. Camp's notice of Edwin's death in the papers I suppose.

I did not intend to winter here but waiting from time to time to hear from Edwin the season had gone by before I knew how to act. As circumstances now are I would gladly get rid of all connection with Fort Madison and plant myself in Belleview.

I love that plan but I don't know as I should love it if you were not there; and I don't know if you intend ever to go there.

Two years ago I made all the powder that I thought I should ever see—now it is all gone and I must not think of leaving here until I make some 2 or 3 years' supply more. I hope to do this by May, when I shall be off in a hurry for Chicago.

I live with Cynthia but shall soon fit up the old vinegar house in Jewettsville or the powder mill and live again as I once loved to do—and cook my own dinner. Cynthia has a beautiful home and filled to the ridge pole with rich furniture. Two nights ago she had a great party and was in her element. Cynthia is not much changed since you knew her, only she studies Divinity a good deal and goes to church steadily. She had a Christmas present of a 50 dollar cloak—a rich one it was, well, I tell her I fear she gains so steadily of late—maybe to set an example of taste in dress: Well, if she takes pleasure in such things it is all right. When I have told one more story you will know all about us here. Last night, about 9 o'clock I came in from outdoor—says I, Cynthia, this is a woeful night—it is very dark and the wind and rain and snow drives hard enough to blow a person away. Oh, I guess I can stand it—Mat, put pony onto the Buggy and I will go to town after Francis. And away she went. Her husband has been very fortunate in mercantile business and is now the first merchant in Sackett's Harbor he has a partner but he is all in all at the top.

We have discussed the question here to-night where is Harriot and what is she doing at this moment? Eight o'clock and agreed it was at church. I wish to dicuss with you all kinds of plans for the future, and ask a thousand questions. Have you found a plan since I saw you or a pursuit or line of business with which you are better suited than with any plan of going back to Belleview? Would you be glad to sell your lands in Belleview and lay out the money elsewhere? If so how much money would you be well pleased to have for it? Would you be glad to have me put up a good home there and make you mistress of it, either on your land or mine. You know Potter spoiled my building lot because I had no water on it and if I built on my lot I should have to do so at the old log Cabin on the South side. Now I wish you to write to me and tell what future course you would like to have carried out. I can spend a good deal of time in Iowa and should if I had a home there; but I have great reason to stop here—my affairs, although I lose a great deal of money by Edwin are greatly prospered and I have fairer prospects ahead than I have had for many years.

I could have made a fortune if I had gone to New York as I was urged last fall by making sweet whiskey which you remember taking when suffocated with Charcoal. You see it called Chloroform and the newspapers are beginning to give me the credit of discovering it. I made the first particle that was ever made and you are the first human being that ever used it in sickness. This is likely to prove the grandest discovery in medicine the world ever saw. By breathing it a few seconds the person falls apparently into a sweet sleep—when breasts, legs and arms may be cut away —painful labors ended and all without pain or injury.

Feb. 26. I have kept this back a month, to see what might happen; but last night we heard you were out on the canal and sick, which gave us great anxiety to hear from you and I hurry this off in the hope you will write to us at once. I want to know your plans, your wishes and your intentions. Do you wish to go back to Belleview? Do you wish to come back to Sackett's or have you good prospects by remaining at Chicago, which you prefer to avail yourself of. It is bad policy at any ways to reside on the canal if you are to ruin your health and constitution both of yourself and children by it. It seems that Alfred is in high luck; but has probably his hands full to provide for his own dependents.

My health is much as when I saw you—I have a good many bad days; but I hope to stand my spring job of making powder, which if I do will place me in a grand situation. That is, will give me years of leisure and a certain money income fully equal to all my wants for some years. But there is no happiness without a home and now I have none. I have just sold the A. S. house. I have bought wheat, lot and have expended about 100 dollars on the place and have sold for 500 dollars; but don't expect to live long enough to see it paid for. I am to get 50 dollars on delivery and the rest in years to come. It is a lovely place, but it is gone.

Adeline is very poor; but probably she will be well provided for by her country, which I think will better suit her father than to do it himself.

Inclosed are ten Dollars for little Newcomer to the care of his mother. Write everything you can think of.

Don't neglect to tell us what you wish to do and what you intend to do.

Affectionately yours,
S. GUTHRIE

February 29, 1848.

The little "newcomer" for whom his grandfather enclosed the ten dollars, was Harriot's youngest child, Thaddeus Samuel Chamberlin—born September 6, 1847, in Chicago, and now living there in his eightieth year. The origin of this essay is due entirely to this gentleman. Several years ago, he generously placed at our disposal, all the available Guthrie data, and from time to time added to it. It is to be regretted that Mr. Chamberlin was unable to send us his grandfather's portrait, but as the features of this experimenter were scarred by numerous explosions—he was brother to Bunsen and Edward Robinson Squibb—and were further disfigured by tic douloureux, he permitted only one daguerreotype of himself to be taken, and he destroyed that one with an expletive. So Samuel Guthrie, like Kaspar Friedrich Wolff, comes down the generations without his physiognomy.

Yet in Guthrie's case, we are not entirely without an idea of how the man looked. His granddaughter, Eveline Guthrie Dunn—who was an adult at the time of Guthrie's decease—upon seeing Mr. Chamberlin's photograph many years later, exclaimed in astonishment, "Dr. Guthrie!"—and explained that the likeness was so remarkable that Samuel Guthrie himself might have been the sitter.

On the night of October 19, 1848, when Samuel Guthrie, at the age of sixty-six, passed away at Sackett's Harbor, no ships in Black River Bay lowered their sails, and the guns of Madison Barracks offered no muffled salute. Our present civilization will have to undergo many changes before the scientist ranks in public interest with the soldier and the politician.

Among the wilds of Michillimackinac, the human stomach was first seen and studied in situ, and in the backwoods of Kentucky, woman was first relieved of ovarian tumor. An American pen wrote the first burning protest against the slaughter of mothers in childbed, and an American knife removed the vesico-vaginal fistula from the hopeless afflictions of the female sex. Europe gave to America tracheotomy—bloody and horrible; America gave back to Europe intubation—a procedure so simple that it cannot be classed as surgical. Not from the Askelpion at Epidarus, not from St. Bartholomew's Hospital at London, but from the operating room of the Massachusetts General Hospital first arose the vapor of ether that has spread like a benediction over the earth.

With these pioneers—with Beaumont, McDowell, Holmes, Marion Sims, O'Dwyer, and the discoverers of ether—medical history links the deeds of Guthrie.

The memory of Samuel Guthrie can never die, but it has been sadly neglected by his countrymen. Who has read his diary? Who has seen the condenser which first produced chloroform? Who has made a pilgrimage to the grave of this pathfinder? The house where he lived at Sackett's Harbor is still standing—unmarked, untableted, and unsung. During Ossian's geological researches, he found a boulder of about thirty tons, which he brought to Grant Park as a memorial to his grandfather. The dwellers on the lake front claimed the huge stone obstructed their view of the sunrise on Lake Michigan, and accordingly the unwelcome boulder was removed to Washington Park, where it now rests. Chicago's great surgeon, John B. Murphy, headed a movement, and the Chicago Medical Society appointed a committee to place upon the boulder "an appropriate inscription, setting forth the facts of Dr. Samuel Guthrie's discovery of chloroform." But Chicago is busy; several years have gone by, and the Guthrie stone is still uninscribed. Many people have forgotten its origin, and it is known throughout the neighborhood as the Mystery Rock.

We wish we could letter in unfading bronze this nameless glacial boulder—which in its rugged strength and unadorned simplicity, typifies the life and work of Guthrie. On one side, we would place the words of the poet Henley—how many of us, at one time or another but have echoed them!—

> Behold me waiting—waiting for the knife;
> A little while, and at a leap I storm
> The thick, sweet mystery of chloroform,
> The drunken dark, the little death-in-life—

and on the other side we would write: To Samuel Guthrie, one of the most interesting characters in the early annals of American science, the backwoods chemist who gave to mankind the boon of chloroform.

(1781–1826)

RENÉ THÉOPHILE HYACINTHE LAENNEC

The immense importance of auscultation was at length demonstrated to the world by Laennec, who, after spending three years in the investigation of its phenomena, published those results which have made his name immortal.

JOSEF SKODA.

The result of Laennec's discovery was an entire revolution in the knowledge of diseases of the chest; but it would be a mistake to forget that an essential factor in this revolution was the simultaneous study of the condition of the diseased organs as seen after death. Without the latter, it is difficult to see how the information conveyed by sounds could ever have been verified. This increase of knowledge is therefore due, not to auscultation alone, but to auscultation combined with morbid anatomy. In the case of Laennec himself this qualification takes nothing from his fame, for he studied so minutely the relations of post-mortem appearances to symptoms during life that, had he not discovered auscultation, his researches in morbid anatomy would have made him famous.

JOSEPH F. PAYNE.

It is quite improbable, I think, that we should be here to-day, or indeed, have an existence as a society largely devoted to the consideration of diseases of the chest, were it not for the methods of thoracic examination which Auenbrugger and Laennec have given us in their discoveries of percussion and auscultation. Without these two precious methods of investigation we could scarcely have arrived at any degreee of precision or certainity in thoracic pathology.

EDWARD O. OTIS.

XVI

RENÉ THÉOPHILE HYACINTHE LAENNEC

Leopold Auenbrugger was no fool; he had read history, and he knew the usual fate of the innovator: the contumelious stone during life, and a monument after death. Therefore, when sending his *Inventum Novum* out into the world, he wrote this little preface:

> I present to the reader a new sign for the detection of diseases of the chest, which I have discovered. It consists in the percussion of the human thorax and the determination of the internal condition of this cavity by the varying resonance of the sounds thus produced. My discoveries in this subject are not committed to paper because of an itch for writing, nor an inordinate desire for theorizing. Seven years of observation have put the subject in order and have clarified it for myself and now I feel that it should be published.
>
> I foresee very well that I shall encounter no little opposition to my views and I put my invention before the public with that anticipation. I realize, however, that envy and blame, and even hatred and calumny have never failed to come to men who have illuminated art or science by discoveries or have added to their perfection. I expect to have to submit to this danger myself, but I think that no one will be able to call any of my observations to account. I have written only what I have myself learned by personal observation over and over again, and what my senses have taught me during long hours of toil. I have never permitted myself to add or subtract anything from my observations because of the seductions of preconceived theory.
>
> I would not wish, however, that anyone should think that this method of diagnosis, which I suggest, has been developed to its utmost perfection. I confess with all candor that there are defects

which conscientious observation will, I hope, amend with time. It is possible that there are even other important truths for the recognition of disease still hidden from this method of diagnosis. Some of these may prove of great usefulness for the differentiation, prognosis and cure of diseases of the chest.

This was the reason why in my personal experience, after I had succeeded in finding the signs in the chest and proceeded further to the investigation of their causes so far as my own observation could help me, I have always afterward had recourse to the commentaries of the most illustrious Baron Van Swieten, since I have considered that whatever can be desired by an observant man is sure to be found in his work. I have thus been able to spare you a long disquisition. I have found in his work a sure basis of knowledge on which my slight superstructure may be raised up to view.

I do not doubt, however, that I have accomplished a work which will earn the gratitude of all true devotees of the art of medicine, since I have succeeded in making clear certain things which shed not a little light on our knowledge of the obscure diseases of the chest, a subject hitherto very imperfectly understood.

I have omitted many things that seem doubtful because they are as yet not sufficiently elaborated. I shall endeavor, however, faithfully to devote myself to the further development of these points. Finally, it has not been my effort to write in any elegant diction. I have chosen a style in which I may be thoroughly understood.

It will be noticed that in this foreword Auenbrugger refers to his teacher, and throughout the monograph the name of Van Swieten is mentioned with the greatest respect. Van Swieten certainly had merits as a medical man: when he was called over from Holland, the Austrian throne had no heir; but Van Swieten drew the husband aside, gave him some private instruction, with the result that Maria Theresa became pregnant sixteen times. Van Swieten spent most of his life writing eight huge volumes of commentaries on the aphorisms of his master Boerhaave, and though some say that the commentaries are more valuable than the aphorisms, neither one nor the other is now read. Van Swieten wrote much on the diseases of the chest, but he did not mention percussion. The eminent doctor saw no use in tapping the thorax. He did not know that his pupil's finger had ushered in the era of modern diagnosis.

Gerhard van Swieten's successor, the unpleasant Anton de Haen, left eighteen volumes behind him—including a treatise in defense of witchcraft. The historical student who digs among these paper ruins will find the author complaining that it is almost impossible to recognize thoracic diseases until it is too late to help the patient. The obstinate man did not see that in response to the physician's rapping, the door of thoracic knowledge opened.

But Auenbrugger had anticipated neglect, and he was too well poised to permit himself to be embittered or become exasperated. He devoted himself to practice, made money, went to the opera in winter, cultivated a garden in summer, wrote a libretto for the amusement of the empress, kissed his beautiful wife every day, and lived to celebrate his golden wedding.

While Auenbrugger was growing old in Vienna, a child was growing up in Brittany. He was sickly-born, the offspring of a tuberculous mother. One day, when the child was six years old, the neighbors came in and looked at him sympathetically, and the women patted him kindly on the shoulders, for his mother was dead. His father was a lawyer, but the versatile advocate wrote poetry like Desforges-Maillard and was too busy in other respects to be bothered by a frail orphan. He brought the boy to his grand-uncle, an Abbé at Elliant.

The uncle saw the child was obedient, and decided there would be another priest in the family. From him René Théophile Hyacinthe Laennec received considerable misinformation which he never forgot. The child was well-treated, and it seemed as if his existence would be eventless—he would quietly pass from his uncle's district to a parish of his own. For what can happen in Brittany? It is the land of the past, the province of the dead. In La Bretagne only the cock and the artist welcome the rising sun. To study a Breton peasant is like turning over a well-preserved half-animated fossil. His skull is thick enough to resist the advances of French civilization. He will not even speak French, but still whines out his barbarous *patois,* for he is convinced it is the language Adam and Eve spoke in paradise.

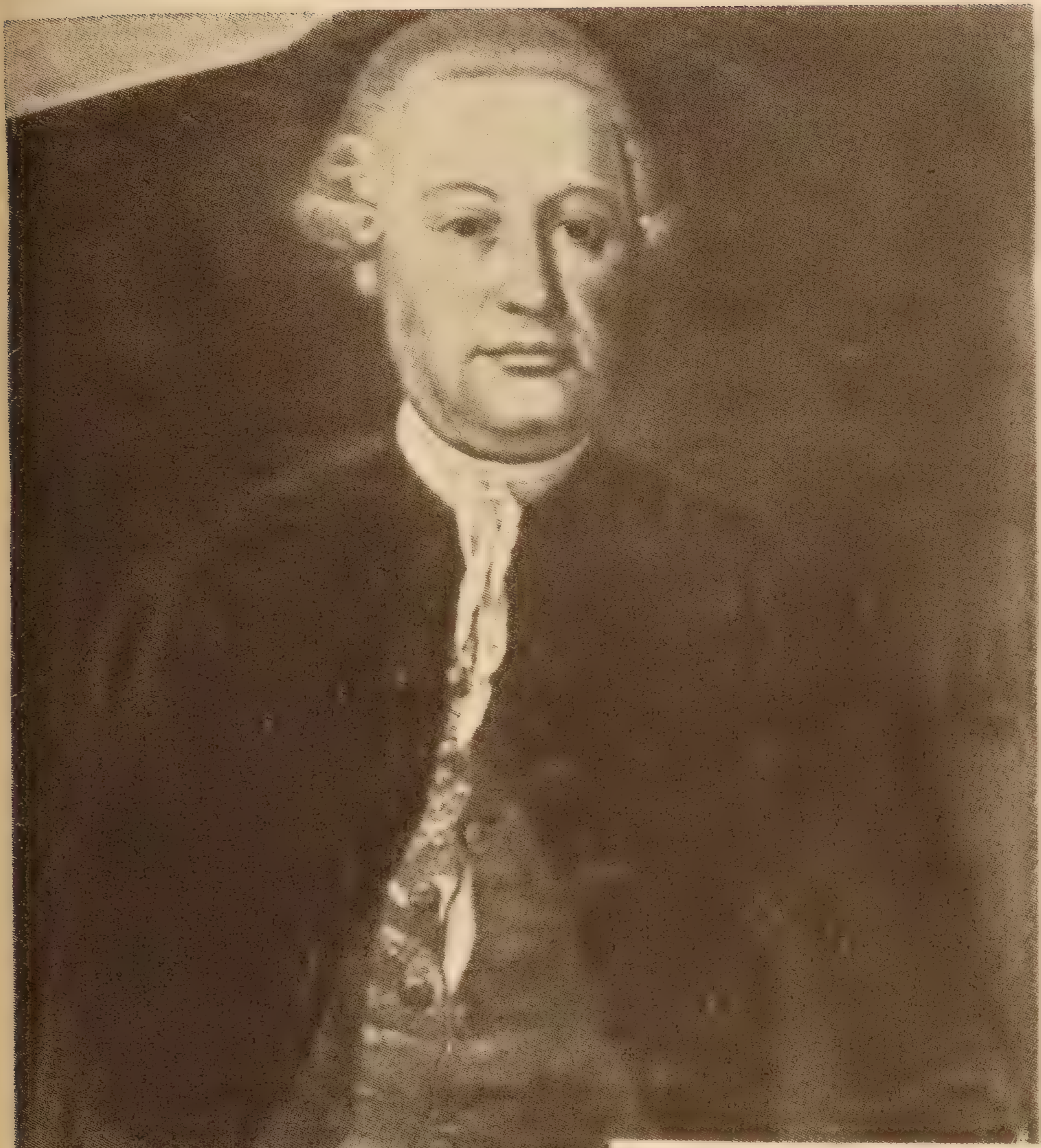
The Breton folk are as unchangeable as the Druidical dolmens and menhirs which litter their country. They are victims of the *idée fixe;* in politics and religion a new thought will never filter through Brittany. In a thousand, or in five thousand years, when the present theology disappears with its predecessors, the last Christian will be a Breton peasant.

The Bretons have never had any interest in the rest of the world, but outsiders have printed and painted the name of Brittany with praise. This is because Brittany is visited chiefly by clergymen who need a rest, and by artists in search of color. The former eulogize Brittany on account of the docility and piety of the inhabitants, and the artists are enchanted because the men wear long hair, broad-brimmed hats, blue blouses, large belts and baggy breeches of sail cloth, and because the women dress in white caps with wide lappets, and, instead of corsets, are arrayed in pretty spencers laced up in front of the waist which open above to allow for the swell of the bosom.

When René Laennec was nine years old, strange deeds were done in his quaint and picturesque Brittany: churchmen, including his uncle, were banished. Excited Frenchmen ran along the roadways, crying *Liberté, Égalité, Fraternité,* and pulling down the crucifixes: they had much work to do, for in Brittany wherever two roads meet, there a crucifix is erected. What was happening? Was the world coming to an end? Ah, the world was being saved. It was the great and glorious French Revolution.

From the Reign of Terror issued an ocean of blood, but that scarlet stream watered the tree of liberty; in eternal letters it wrote the Rights of Man; it cast the oligarchs and the theocrats down; it exalted the disinherited of ages; it overthrew a royal carnival of crime hideous beyond belief; everywhere it uttered the glad tidings, *Nous avons changé tout cela.*

As might be expected the antiquated Bretons fought on the



[ABOVE]

Leopold
AUENBRUGGER
(1722-1809)
whose
Inventum Novum
(1761)
contained his discovery
of thoracic percussion.
This fundamental
contribution to physical
diagnosis was largely
ignored by the profession
until one year before
Auenbrugger's death —

[BELOW]

Jean-Nicolas
CORVISART
(1755 - 1821)
translated it from
the Latin
Nouvelle Méthode
(1808),
showing its
rightful place in
modern medicine.

side of the old monarchy against the new republic. It did not matter to them that there was a law in France which gave the nobles permission to shoot at workmen on roofs, merely for the sport of seeing them tumble off. Probably the fact that an aristocrat was not expected to kill more than two toilers during a day's merriment—otherwise, labor would grow scarce,—made the honest Breton heart pulsate with devotion towards his merciful superiors. As an experiment it might be interesting to attempt to educate the cattle of Brittany—excluding the dullest beast of the field, *la vraie Bretagne bretonnante.*

After the Abbé's proscription, the boy was sent home to his father. "Mon Dieu," exclaimed that gentleman, and suddenly remembered that René had another uncle, Dr. Guillaume François Laennec: a pupil of John Hunter, and professor of medicine and materia medica at the University of Nantes.

For ten years René remained under his guardianship, and here it was settled that he would follow in the footsteps of his medical relative. Then came the desire which in every period stirs all ambitious hearts that beat in provinces: to study in the capital. In the year 1800, at the age of nineteen, Laennec came to Paris.

Within the mesh of Parisian gayety many a youthful student from the provinces has been lost, but Laennec had come for the college curriculum, and the world of merriment had no meaning for him—although he could dance and write verse and play the flute. He soon became connected with the Journal of Medicine, a periodical which he eventually edited, but which in those days was conducted by Corvisart, Leroux and Boyer.

Two years after his arrival in the French metropolis young Laennec had a reputation, for in his twenty-first year he gave to medicine its first satisfactory description of peritonitis. Among his other early accomplishments were his minute reports of four hundred cases of disease, and his original accounts of the sub-deltoid bursa and the fibrous capsule of the liver. No one seemed to know so much about the tunics of organs as did Laennec.

The passing years still found Laennec in the dissecting-room, and here he saw the condition which he designated melanosis, and the post-mortem wart. Laennec's catarrh, Laennec's perles, Laennec's cirrhosis, Laennec's thrombus, and Laennec's râle are some of the monuments he erected along the pathological highway. To him we are indebted for the standard pictures of such diseases as bronchiectasis and esophagitis, and among the permanent additions to our nomenclature are several terms of his devising, such as ægophony and pectoriloquy.

Laennec was a favorite pupil of the great cardiologist, Jean Nicolas Corvisart, who had a mighty name in those days, for he was physician to the demigod who emerged from the wreck of the French Revolution. Napoleon had a cold in his chest, and was suspicious of the attendants who felt his pulse and looked at his tongue. He was told there was a doctor who diagnosed troubles in the chest by examining that part of the body. "Send him to me," said Napoleon. Corvisart came, and tapped the imperial thorax with his finger-tips. Thereupon Napoleon decided that Corvisart should have the honor of looking after his majesty's health. They grew so intimate that after the birth of the King of Rome, Corvisart was audacious enough to lecture the world's chief phenomenon: "Sire, this prince must crown all your wishes! Recall your career: in less than ten years a simple officer of artillery, then captain, general of brigade, general-in-chief, first consul, emperor, spouse of an archduchess of Austria, father of a prince. Having reached so dizzy a height of fortune, rarely attained by any mortal, I beg of your majesty to stop! Fortune may turn; you may yet fall."

"You speak like a peasant," answered Napoleon.

But we must not forget to ask: Where did Corvisart learn percussion? De Haen's successor was Maximilian Stoll, who had the misfortune to marry the meanest woman on earth, but who was one of the most enlightened members of the Old Vienna School. Stoll praised Auenbrugger's work, and a pupil of Stoll, named Eyerel, wrote a treatise on percussion which came to Corvisart's notice. Later Corvisart came across Auenbrugger's *Inventum Novum,* and decided to translate it. "I know very well," wrote the generous Frenchman, "how little reputation is allotted to translators and commentators, and I might easily have elevated myself to the rank of an author, if I had elaborated anew the doctrine of Auenbrugger and published an independent work on percussion. In this way, however, I should have sacrificed the name of Auenbrugger to my own vanity, a thing which I am unwilling to do. It is he, and the beautiful invention which of right belongs to him, that I desire to recall to life."

Before Corvisart, percussion was the possession of a handful; after Corvisart, percussion became common property. The torch which Auenbrugger kindled, Corvisart re-lit for all futurity. So we see that though the torch of truth often flickers low, yet its immortal light is never wholly quenched. Floods of misunderstanding may roll over it, the weight of authority may threaten it, but throughout the long night it glimmers faithfully, waiting for the truth-seeker who will raise it aloft and bring morning to the intellectual world.

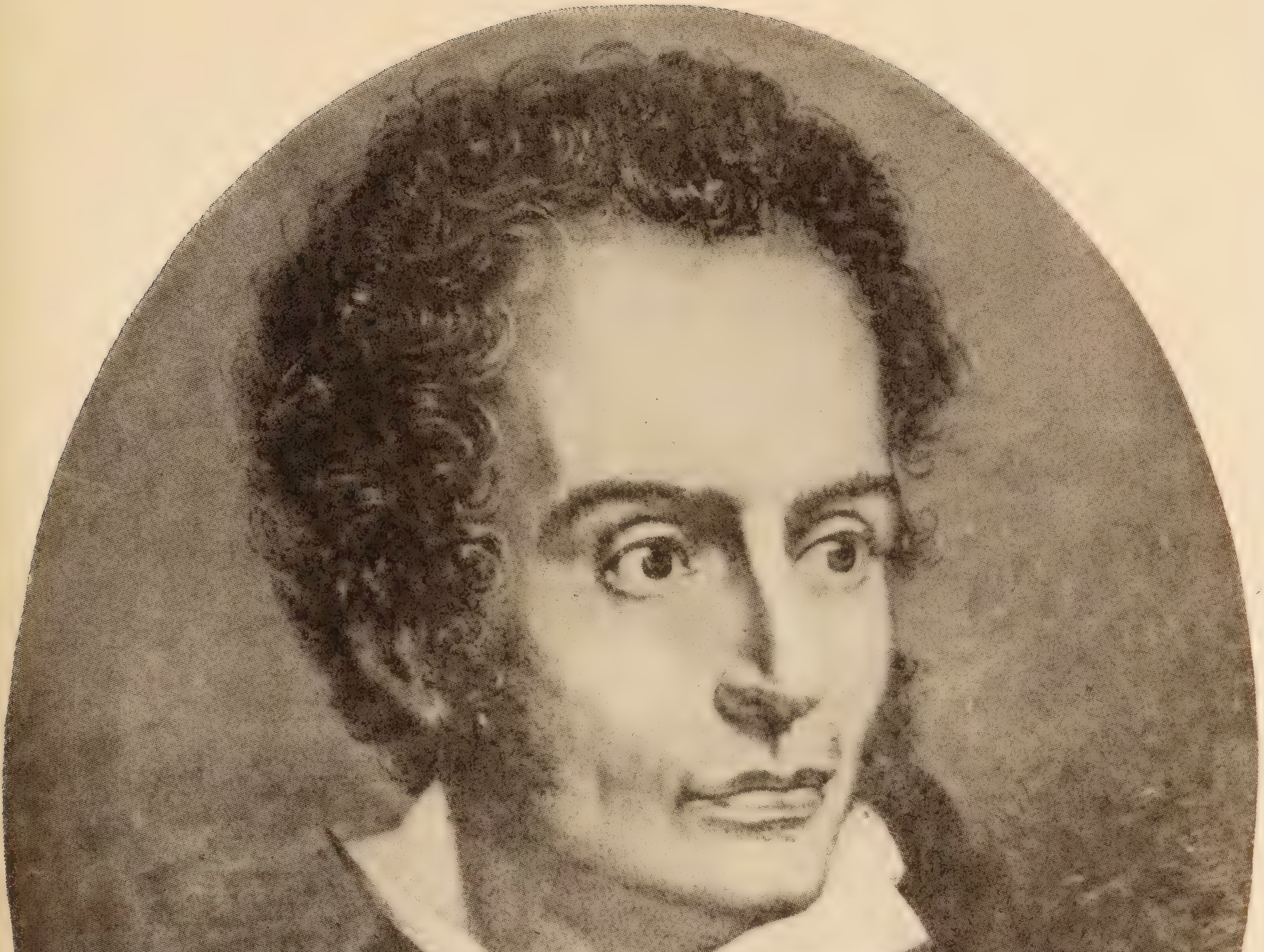
Besides Corvisart, Laennec's name is associated with that of Broussais, but in a very different manner. With Corvisart he came into loving contact; with Broussais he was in angry conflict. Laennec had no use for Broussais, and Broussais saw no good in Laennec. Broussais was a master of sarcasm, and Laennec was not backward in bandying scorn. No doubt Broussais was more talented in this respect—he handled words as he had handled a cutlass during his army life—but then he had numerous and varied hatreds, while Laennec could concentrate. When he spoke of Broussaisism his voice became acid, and his eyes shot sparks of indignation through his tortoise-rimmed spectacles. What must have added special piquancy to the warfare between Broussais and Laennec was the circumstance that both were Bretons, and of all people in the world none are so chauvinistic as the folks that hail from Brittany.

Broussais was the medical theorist of the hour, and elaborated a complex system of "physiological medicine," but Corvisart and Laennec accepted only the Hippocratic watchword, Observation. Neither of the contestants was fair to the other, but it must be said that most of Broussais's theories are now as obsolete as his hirudinomania, which was carried to such an extent that within a calendar year it became necessary to import forty-two million leeches into France. At one time there was hardly a French belly which had not given nourishment to these bloodsuckers.

His theory of irritation as the cause of disease had great vogue in its time, and Oliver Wendell Holmes who heard Broussais in his latter days, told his Harvard students, "The way in which that knotty-featured, savage old man would bring out the word irritation—with rattling and rolling reduplication of the resonant letter *r*—might have taught a lesson in articulation to Salvini." Broussais spun theories, and obstructed science: he belongs with Stahl and Rasori. Laennec discovered facts, and modernized medicine: he belongs with Hunter and Louis.

In 1812, eight years after his graduation, Laennec was appointed physician to the Beaujon Hospital. As conscientious as he was gifted, and willing to work to the point of exhaustion, Laennec became one of the most renowned pathologic anatomists of the nineteenth century. He was particularly interested in the diseases of the chest, and of course employed percussion as he learnt it from Corvisart, but no one yet knew that Laennec was to be Auenbrugger's spiritual heir.

The malady which Laennec studied above others was tuberculosis, the insidious foe which killed the woman who gave him life. Day and night his thin hands grappled with the ancient enemy of the human race. Immemorial indeed, for who shall say in what distant epoch this subtle thief first gained access to the lungs of man? Who knows in what dark and nebulous time a primeval mother first listened in an agony of helplessness to the hacking cough of her infant? We are aghast at the mortality-tables of a sanguinary war, but on the white bed of consumption fall more victims than on the red field of battle.



LAENNEC

In 1816, Laennec was transferred to the Necker Hospital. During this year a woman who was suffering from heart trouble consulted him. Laennec questioned her, but was puzzled how to proceed with the examination. There was no use in thumping her thorax, for the patient was too stout; neither could he put his ear directly upon her breast, for she was still young. We may argue that physicians have privileges, but Laennec himself claims that immediate auscultation was inadmissible. In his dilemma he happened to recollect a fact in physics. Acting on the idea, he rolled a quire of paper into a kind of cylinder and applied one end of it to the region of the patient's heart and the other to his own ear. This was the first stethoscope. Then René Laennec heard the language of pathology. A diseased heart appealed to him for aid. Injuries that for centuries had been inaudible, now found a voice. A sick organ murmured its tale of woe into the ear of a great and sympathetic physician. Auscultation, the crowning glory of physical diagnosis, came into existence.

In the guesses of philosophers like Democritus, who had nothing except the deductive method, we find foreshadowed nearly every principle of modern science, but the ancients knew practically nothing of auscultation. Even Hippocrates refers to the subject but once, and his observation is erroneous. He says in *De Morbis,* "You shall know by this that the chest contains water and not pus, if in applying the ear during a certain time on the side, you perceive a noise like that of boiling vinegar." Aretæus too seems to have known and practiced a sort of auscultation, but otherwise medical antiquity had no ear.

In the seventeenth century the Englishman Robert Hooke stumbled upon the truth, but although this versatile genius sowed seeds in twenty different fields, he never remained to harvest the crop. There is still enough unworked soil in Hooke to support discoveries for the next three centuries:

> "I have been able," wrote Hooke, "to hear very plainly the beating of a man's heart; and it is common to hear the motion of the wind to and fro in the guts and other small vessels; the stopping

in the lungs is easily discovered by the wheezing, the stopping of the head by the humming and whistling noises, the slipping to and fro of the joints, in many cases by crackling and the like. As to the working or motion of the parts one amongst another, methinks I could receive encouragement from hearing the hissing noise made by a corrosive menstruum in its operation, the noise of fire in dissolving."

Rarely has an investigator in medicine had so few predecessors as Laennec. After his invention Laennec toiled like a fanatic. An undersized body did the work of twenty men. He improved his stethoscope, and with his instrument discovered many secrets in the wondrous box that holds the heart and lungs. He began also to write out his observations. As the industrious days went on there gathered on his desk a pile of manuscript which looked as if it weighed more than the author. At last he was ready to write the preface, which is somewhat reminiscent of Auenbrugger's foreword:

"I may say," wrote Laennec, "that no one who has made himself expert with this method will have occasion to say with Baglivi, Oh, how difficult it is to diagnose disease of the lungs! But our generation is not inquisitive as to what is being accomplished by its sons. Claims of new discoveries made by contemporaries are likely for the most part to be met by smiles and mocking remarks. It is always easier to condemn than to test by actual experience. It suffices for me if I can only feel sure that this method will commend itself to a few worthy and learned men who will make it of use to many patients. I shall consider it ample, yea, more than sufficient reward for my labor, if it should prove the means by which a single human being is snatched from untimely death."

It was now ready for type. The manuscripts became proof-sheets, the proof-sheets became printed pages, and the printed pages became a book. Laennec's *Treatise on Mediate Auscultation* is universally recognized as an imperishable medical classic. But the author took no joy in his finished work. His life, his strength, his spirit, had gone into the making of his book. The book was vital with robust and fresh-blown power; the writer was weary, broken up and undone. Laennec lost interest in everything. Food was set before him, but he could not eat. A bed was prepared for him, but he could not sleep. He breathed with difficulty, he suffered from muscular debility, the slightest exertion being followed by the greatest prostration, and often he fainted. A deep melancholy sat upon him: he was a picture of an overworked neurasthenic.

Laennec had just enough sanity in balance to know that he must escape from Paris and return to Brittany. So he left the crowded hospital-wards, and after a terrible journey, stood once more in Kerlouarnec near his native town of Quimper. The sea-breeze came from the shores of the Bay of Douarnenez, and the hills and the forests were green. Laennec smelled the air fragrant with fresh butter. He saw the long-haired peasants stand knee-deep in fields of buckwheat; he heard the girls singing as they drove the cows home from pasture, and he felt that here he might recover. Nature was his physician, and she prescribed him daily doses of the earth and the sea and the sky. Abstaining from mental effort, he spent his time in the open air, riding horseback, angling in the stream, hunting the woods for foxes and partridges. The breath of a new life entered that wasted frame; color crept into those pallid cheeks. "Anne, cook this pair of snipes," he said, as he put down his bag and rifle, "I'm as hungry as a bear." The household was in delight—René was getting well.

For two years Laennec lingered in the neighborhood of Quimper. Quimper is the quintessence of Brittany—everything characteristic of the province has retreated and crystallized there. Quimper has not wound her clock for centuries, and the sands in her hour-glass do not run. It is the same time now that it was when the Druid priests chanted their heathen hymns under the oaks, and if they returned they would see the monuments they erected still standing—but surmounted by a cross. In Quimper, on the cradle and the grave alike, falls the dust of a distant past.

Laennec loved Quimperism—who ever heard of a Breton that did not relish the very dung-heaps of Brittany? Breton sailors have been known to pine so passionately for their native land, that they died heart-broken upon the voyage. Laennec was sympathetic towards the peasantry, and was ever ready to use his medical skill in their behalf—and forget the fee. As a member of the Ultramontane Church, Laennec was a determined enemy of free institutions, autocracy was his ideal, democracy was a red specter to him, but though Laennec would not trust the common people to govern themselves, he was fond of them, for a man's theories do not fundamentally affect his character.

But with the return of health came the conviction that a physician's place is at the clinics and not on the mossy banks where at twilight the poet reclines. He thought of the endless invalids at Paris who were victims of improper diagnosis—he should be there with his stethoscope. It was time to exchange the gossamer ferns of the fields for the delicate gauze of the wards.

Laennec was again at Paris. During his absence his pupils had carried on his work, his book had established his reputation as a leader of the French school, and honors awaited him. Not only was he made Professor of Medicine in the College of France, not only did he receive the chair of clinical medicine at the Hospital La Charité, but he had the felicity to be appointed physician to the Duchess of Berri. We need not be surprised at his gratification, for the royalty-superstition, barbarous though it be, seems inbred in the bones of man. Even so liberal a thinker as Huxley felt flattered when he was granted an interview with a rather fattish widow, who through no merit of her own happened to be a queen. Goethe was a lifelong sycophant at the court of Saxe-Weimar, and when the duke rode off to join the armies of the Allies who endeavored to replace Louis XVI on his bloody throne, the author of *Faust*—let the Muses blush—followed the duke.

But Laennec was more interested in the hospital than in the noblesse; essentially he was a physician, not a courtier. Again he forgot the limitations of flesh; his earnest spirit would not

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Drawn from life in 1825 by Charles James Blasius Williams (1805–1889), and reproduced in his autobiography, Memoirs of Life and Work (London, Smith, Elder, & Co., 1884). The book likewise contains sketches of Andral, Gay-Lussac, Thénard, and Pouillet.

let him rest. Bayle had demonstrated that when tubercles are present in the lungs, the patient has tuberculosis—but the doctor could not recognize the condition until the hectic fever set in and the pus was spat up. By auscultation, however, tuberculosis could be diagnosed in an early stage, and thus the labors of Laennec began to reduce the death-rate of the most prevalent of diseases. The impetus which Laennec gave to the study of thoracic troubles, was felt throughout the medical world. In this instance the triumvirate of the Dublin School of Medicine especially distinguished themselves: Graves, by his fresh-air propaganda for tuberculosis; Stokes, by the book on the stethoscope that he wrote in his twenty-first year; and Corrigan, by his work on Permanent Patency of the Aortic Valves. To the Hospital La Charité came students from all nations to hear the lectures of the diminutive, narrow-chested man, who first raised a hopeful voice against the Great White Plague.

In connection with Laennec, another Irishman should be mentioned, David Barry, whose name has been thus embalmed in the pages of Laennec's book:

> As in the preceding discussion I have constantly used the expression of contraction of the auricles, I think it necessary to remark that I do not by this intend to prejudge the question lately agitated by my friend, Dr. Barry, a distinguished physician of the English army. This gentleman has endeavored to prove, by direct experiment, that atmospheric pressure is the chief cause of the circulation in the veins. He remarks, in the first place, that the dilatation of the chest in inspiration, produces a tendency to a vacuum in the whole thoracic cavity; that the walls of the pericardium and heart follow the motion of the chest; that, consequently, at the very time the air rushes into the bronchi, the blood is rapidly sucked up by the right auricle, and is precipitated into the left auricle, as well from the same cause as from the pressure exerted on the pulmonary vessels.
>
> The chief experiments on which Dr. Barry founds his doctrines, are the following: 1. if we introduce into the internal jugular vein of a horse, a bent glass tube, and place the other extremity of it in a vessel containing a colored fluid, we find this drawn into the

vein at each inspiration, until it is all exhausted; 2. the same experiment made by adapting the glass tube to a metallic one introduced into the pericardium gives precisely the same results; 3. having laid open the abdomen of a horse, and separated the vena cava, if we lay hold of the latter, we find the vein become emptier and flaccid during each inspiration.

Having myself witnessed several of Dr. Barry's experiments, I am convinced of the correctness of his opinion respecting the influence of atmospheric pressure on the circulation in the veins; and I consider his discovery as the most remarkable addition that has been made to that of his illustrious countryman, Harvey.

This linking of Barry with Harvey is curious, for in spite of Laennec's eulogy, the name of his friend has disappeared from medical history. In the indices of standard works we look in vain for David Barry, and available biographic data are limited to an obituary notice in the Medico-Chirurgical Review, and to a single paragraph in the Dictionary of National Biography. Yet his career is of sufficient interest for an extended study. No other child of Roscommon county was so much at home in the scientific circles of Paris. His work, "Experimental Researches on the Influence exercised by Atmospheric Pressure upon the Progression of the Blood in the Veins," appeared in French before it was published in English. Not only Laennec, but Cuvier and Cruvelhier applauded his experiments. In 1828, when yellow fever raged at Gibraltar, Barry sailed to the Rock with a group of French physicians which included Louis and Trousseau; he took part in the preparation of the report, thus becoming joint author with two of the foremost names in modern French medicine. Like Louis, he visited Russia—for the purpose of studying cholera—and upon his return was knighted. He was not entirely divorced from Ireland, being a member of a commission which investigated its medical charities. Sir David was a genial man, one of the gayest banqueteers in the profession; one night, he was "the life of the party" as usual; the next morning he was violently ill, and a bursting aneurism removed him from the feast of life.

After the elapse of a few years it was necessary for Laennec to prepare a second edition of his *Treatise*. "Second edition" to the majority of authors means the correction of a few errors, the addition of a few notes, the insertion of the legend on the title-page, Revised and Greatly Enlarged, and an expression of gratitude in the preface that another edition was required. But to so conscientious an individual as Laennec, a second edition meant the re-writing of the entire book. To write a book with the sweat of your brain and your heart's blood is a serious thing; nature usually throws nervous prostration into the bargain. For a quarter of a century Lagrange worked on his *Mécanique Analytique,* but when the volume was finally printed, the author let it lay for over two years on his desk unopened. He was too tired. The efforts that Laennec expended upon the second issue of his magnum opus, together with the Herculean labors which this pigmy performed in the clinics, again wrecked his health on the altar of overwork. In this state his only remedy was Quimperism. Once more he returned to his native region, and life and death struggled in his sunken chest.

A party of travelers presented themselves at a house in Brittany, and knocked for admission.

"What do you want?" asked the man who came to the door.

"We are weary of wandering; let us rest at your hearth."

"Pass on; the roads are full of vagabonds; who knows who you may be?"

"Be hospitable, brother; the sky threatens; a storm is coming."

"If you hasten you will reach the next inn before the clouds burst."

"Listen," says the spokesman of the pretended travelers, "I deceived you when I asked for shelter. I come for another purpose. My young master desires the girl of this house. There was never a youth like him. He can plow as much in one day as three hired laborers; alone he can replace an overturned cart; he has wrestled with all the able-bodied men of the village, and has laid many champions on their backs; in his hand a stick is more powerful than a sword in the hand of a soldier."

"And this maiden," replies the other, "think you there are many as good as she? She is light and supple as the blossom-covered branches of the broom. She is a timid virgin, and when the dance begins, she holds in one hand the hand of her mother, and in the other that of a female friend. But she is not here; she has long left her father's house."

"You deceive me; the yew-tree is made for the church-yard, the rose for the garden, and young girls to grace the home of a husband. Do not throw us into despair! Lead hither by the hand her whom we desire, and we will place her at the wedding-feast near her bridegroom."

"It seems we must yield to you, friend. I will fetch her," and going into the room he comes back with an old woman, and asks, "Is this then the rose you are seeking?"

"From the venerable appearance of this woman," replies the other, "I judge that she has well-fulfilled her task in this world, and that she has conferred happiness on him who has loved her. But she has ended that which the other must now begin. She is not the woman I seek."

The host returns again to the house, and leads forth a young married woman. "Here," he says, "is a young girl, beautiful as a star. Her cheeks are like roses; and her eyes are of crystal. One glance from them can render a heart sick forever! This must be the fair one whom you want."

"Certainly this soft cheek and youthful freshness look like those of a maiden. But that finger, bearing the marks of rubbing—has it not often been rubbed with pap for an infant to suck?"

"Nothing escapes your notice! Tell me, is this she whom you want?" and he brings out a child.

"That is exactly what she, whom I seek, was some years ago. Some day this pretty child will make a husband happy. But she must remain yet a long while on the espalier. The one whom I want waits for the gardener's basket to carry her to the table of the nuptial feast."

"Friend, it is enough," says the bride's spokesman, "You deserve her whom you seek."

Together the two families enter the house. The bride and bridegroom clasp hands, all kneel in prayer, then repair to church, and return for the feast. At the head of the principal table, opposite each other, sit the happy couple, and between them is placed a gigantic dish of butter. Hundreds of peasants are present; they eat and drink and dance; they swallow a flock of ducks and chew a herd of cows—they eat and drink and puke. They gulp down barrels of liquor till we marvel at the capacity of the human alimentary canal. They eat and drink and roll under the tables, every atom drunk.

At midnight, in the presence of the company, the bride is undressed and put into the oaken bed; the bridegroom jumps in beside her, walnuts and wine are passed to them, and the celebration continues. Gradually those guests who are not asleep begin to take their departure, and Quimperdom grows as quiet as usual—so quiet that in the silent night we can hear a hacking cough. Laennec is perishing of tuberculosis. He passes away holding in his hand a cross. He dies modestly, forgetting that the stethoscope has done more for mankind than the crucifix.

Laennec's name remained the greatest in the history of tuberculosis until the epochal evening, two generations later, when Robert Koch read his paper, *The Etiology of Tuberculosis,* announcing that a short rod-shaped bacterium was the sole and only causative agent of the universal scourge. Suffering mankind now awaits him who will discover a remedy to destroy Koch's bacillus. In high expectation Koch himself proclaimed that he had found a specific, but tuberculin alternately raised and lowered the hopes of the world. The Jenner of tuberculosis has not arisen; when he comes, when he brings to the medical market the blessed drug that will materially help to transform consumptives into normal human beings, the historical student will join in the general rejoicing, but he will not forget how much the world owes to the previous labors of René Théophile Hyacinthe Laennec.

(1787–1869)

JOHANNES EVANGELISTA PURKINJE

To tarry at a discovery to its complete exhaustion, a discovery which casts a glamour about other names, was not Purkinje's habit. Driven from one discovery to another, he leaves the details to others; his works are stimulating data for further research. In addition, there are two rare qualities in this exalted spirit: respect for the youngest of talents, and modesty in not speaking of himself; both of these go with his noble character, but they are also to blame for Purkinje's achievements not being honored as they should be.

TH. EISELT, 1859.

XVII

JOHANNES EVANGELISTA PURKINJE

The village of Libochowitz is not on the average map, but it lies near Leitmeritz on the Elbe, a town situated amid such natural beauty that it is known as the Bohemian Paradise. Man has ever done his utmost to despoil all earthly paradise, and during that terrible period which history calls the Thirty Years' War—when a whole generation of humanity shed its blood over myths—most of the families that still remained above ground, departed from this region.

The call of the soil is strong, and though the plow turn up bullet and skull, corn grows well on land that has been watered with blood. The healing years passed over Libochowitz, and the fields of Baron Herberstein were under the care of Agricultural Official Purkinje; his family must have occupied quarters in the baronial home, for here his wife, Rosalie Safranek, gave birth to her son Jan on the seventeenth of December, 1787. Thus Johannes Evangelista Purkinje came into the world in the castle of Libochowitz, and not in a "peasant's hut," as is stated by R. Burton-Opitz and others. For purposes of biography, it is more interesting to be cradled in a peasant's cottage than in a nobleman's palace, but history is inexorable.

The young Purkinje attended school in his native village, and took lessons in music and singing, in accordance with the Czech fashion of those days. His voice paved the way for his further education, and he was sent as a chorister to the Piarists in Moravia, where he devoted himself to philology. He graduated from normal school in Mikulov, and then completed the course in the Gymnasium. When it became necessary to select a profession, Purkinje found that he had grown accustomed to the Piarists, and was attracted to pedagogy, and for these reasons entered the Order of the Piarists as a teacher of ancient languages. His novitiate year was spent in Stará Voda near the Silesian border, from whence he was transferred to Stražnic; after 1806 he proceeded to Litomyšl—all little towns which mean nothing to the reader unless he be Czech. The peace of monastic teaching must have appealed to him in many ways, yet he did not take the vow, and Fichte lured him from the monastery to the university. He had already learned French and Italian—later supplemented by various other modern tongues—and had read widely.

He bade farewell to the Piarists, and came to his country's capital to study philosophy. At Prague he occupied himself also with literature, and for a time thought of becoming a man of letters. He was as frugal as David Hume, and the meager fees he received by tutoring enabled him to live, for in those days scholars possessed the secret of subsisting on ideals. His chief pupils were the young barons, Schutterstein and Ferdinand Hildeprandt; Purkinje looked forward with keen pleasure to accompanying the latter to the Stavnic Mining Academy in Slovenia, but this dream was shattered when Hildeprandt joined the allies in the campaign against Napoleon.

Well-educated but still without a profession, Purkinje now decided upon medicine. It was never his intention to become a practicing physician, but he felt that the medical sciences would give him an insight into nature. Even toward the conclusion of his medical studies the pedagogue's mantle clung to him, and he thought of asking the aid of the Hildeprandt family to establish a special teaching institution of the natural sciences, and he contemplated a visit to Switzerland to acquaint himself with the methods of Pestalozzi and his disciples. In 1818 he acted as assistant in anatomy and physiology under Rottenberg and Ilg; and in 1819 graduated with a dissertation on the subjective aspects of vision. He was already thirty-two years old, an age at which many famous scientific careers have closed.

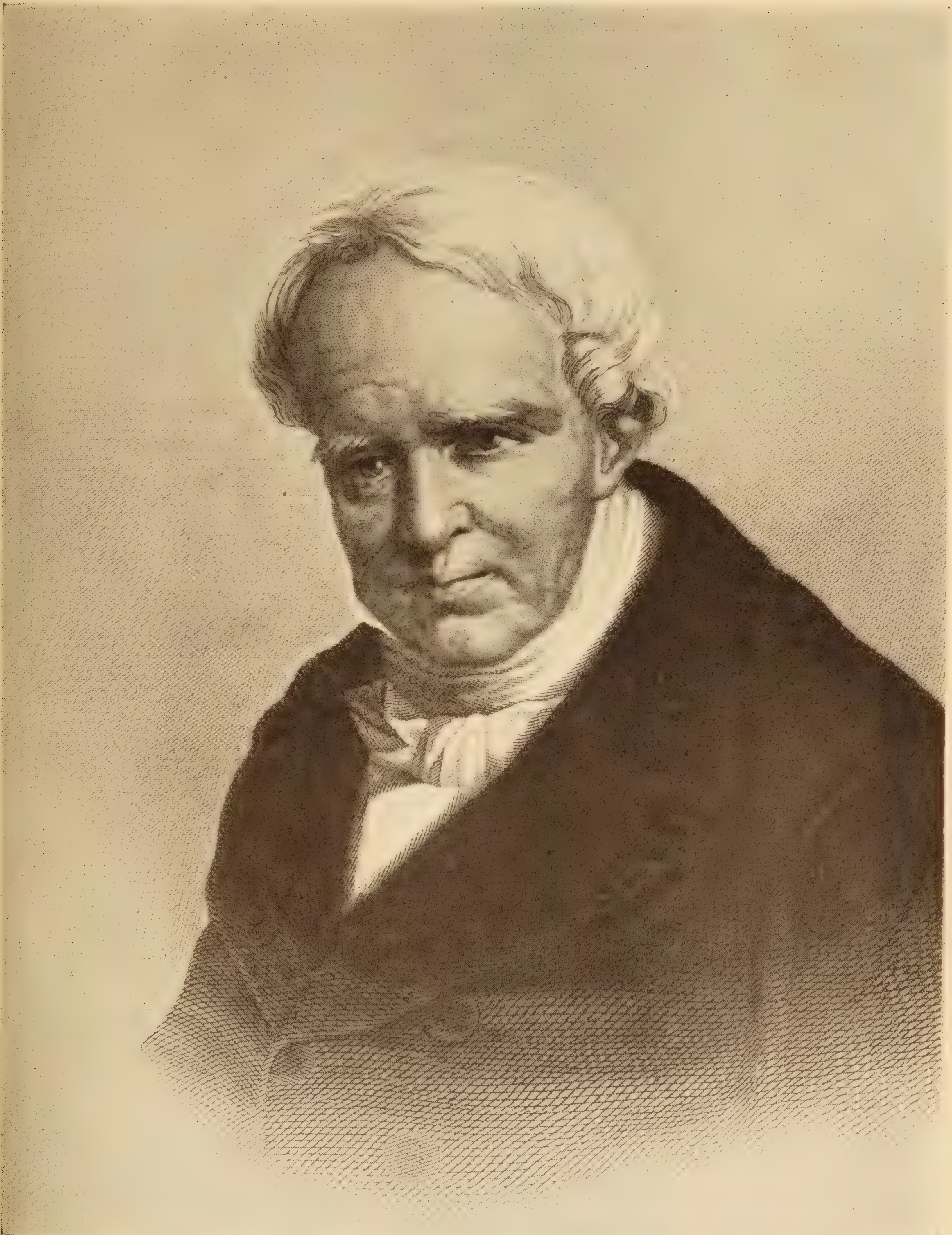
The year 1819 was a troubled one for German students. August von Kotzebue, not content with his popularity as a playwright, had returned from Russia to his fatherland in the capacity of the tsar's paid spy. Establishing a weekly newspaper, he ridiculed the students for their national aspirations, and especially mocked their efforts to secure free institutions. A clever man, the columns of his journal were funny and cruel, but a certain theological student had no sense of humor and killed him. The dagger of Karl Sand gave Metternich his opportunity to muzzle all Germany. Freedom of speech and press were abolished by the Carlsbad Decrees, students were condemned to death for wearing a ribbon, private papers in private houses were searched without warrant, journalists went into hiding, the naturalist Oken fled to Switzerland, professors and pupils emigrated to America, and privy councilor Wilhelm von Humboldt, throwing down his portfolio in despair, relinquished politics forever to devote himself to the mysteries of the Basque tongue and the old Kawi language of Java. Wise Wilhelm von Humboldt! it is always a relief to turn from the world to the cloisters of culture.

In this year the bitter genius of Schopenhauer gave to the German people his masterpiece, but they were in no condition to read The World as Will and Idea. They paid more attention to a pamphlet written by Hartwig Hundt, later suppressed by the censorship, in which the novelist made the suggestion, "As for the children of Israel, let them be sold to the English who could employ them on their Indian plantations instead of the blacks. In order that the tribe may not increase, let the men be emasculated, and their wives and daughters lodged in houses of shame." In times of reaction, all sorts of ideas come to people's heads. Through the turmoil and general consternation, one man remained Jove-like, aloof, serene, going forward with his love-affairs and work: Goethe, unperturbed by Napoleon, was unaware of Metternich. Among innumerable other activities, carrying on his researches in colors, Goethe read Purkinje's thesis with admiration, admitted that it stimulated him greatly, and quoted it frequently. The Bohemian physiologist, like the rest of the world, came to the oracle at Weimar, and Goethe was astonished at his personality and devotion to science. "Such an autodidactic and self-tormenting, talented Piarist," said Goethe, "represents a strange contrast in the midst of the Protestants." It was inevitable that among Goethe's crowded laurels should be entwined this leaf:

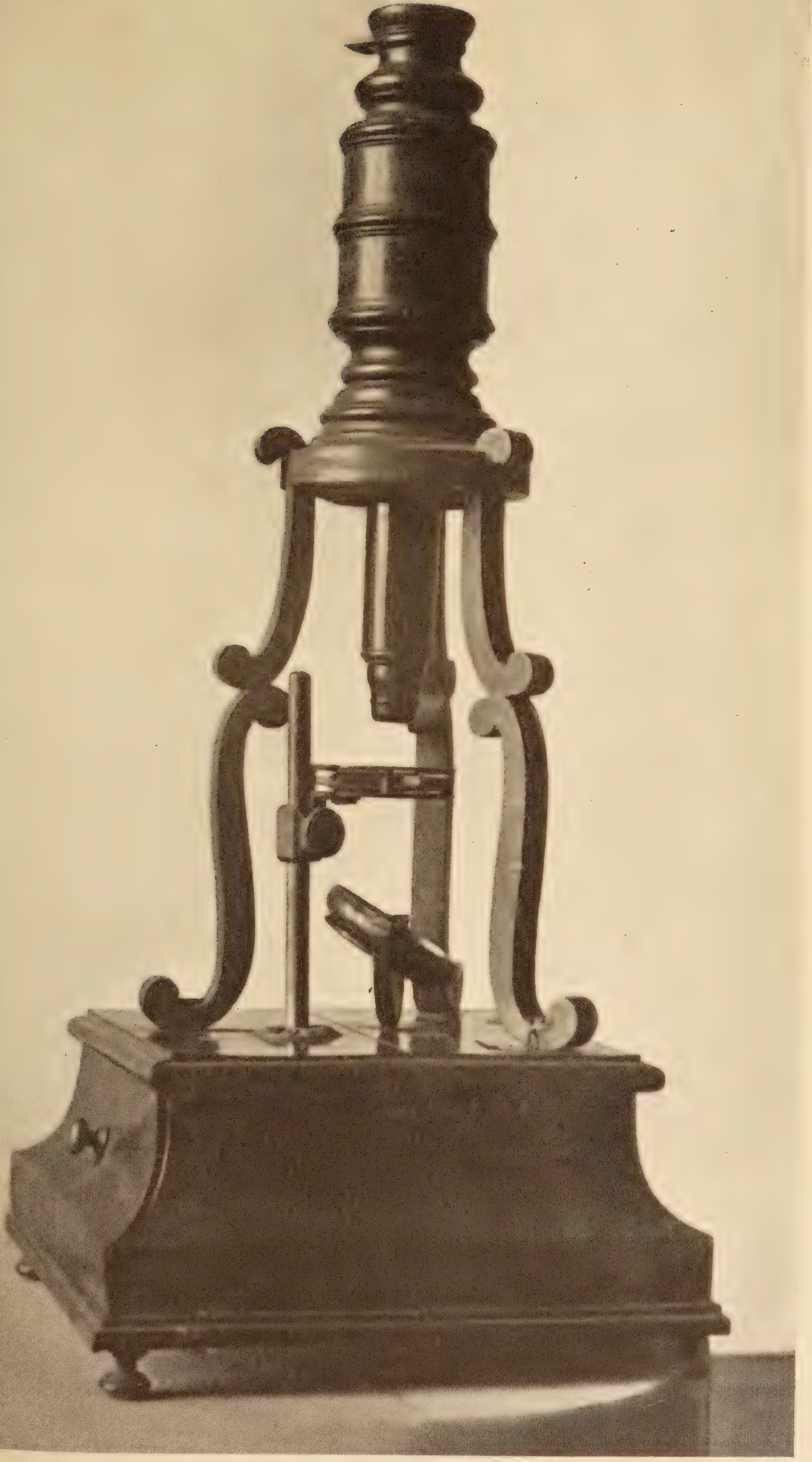
> I have taken the liberty of dedicating to you the second edition of my researches on "Sight from the Subjective Viewpoint" since I could not resist making my strenuous mental efforts a memorial of my sentiments. Let us disregard the fact that the work has been reprinted at the same time in a medical journal; this was not according to the original intention, and is a tribute which my poverty has been compelled to pay to booksellers as the manuscript wandered around hopelessly for a year. I hope this little volume will stir up a little more the phlegmatic interest of the Germans.
>
> I wish to draw Your Excellency's attention to the appearance of the color-spectrums which could also be exploited in the field of applied art, inasmuch as according to the personal observations of Wach, the Berlin painter, the shady parts in colored drapery, yield a clear dark color only when they obtain a light covering of a contrasting hue, when the objective produced by the subjective which has been created by the illuminative parts are eliminated.
>
> I am also sending you a specimen of my researches in the development of the bird's egg before laying.
>
> May you enjoy, with God's help, yet for a long time, your life so precious to us all.
>
> J. Ev. Purkinje.

While serving as house-tutor in Blatná in the family of Baron Hildeprandt, Purkinje had met the Baroness Adelaide Desfours. In those days literature was potent to move men and women, and after reading Schultze's poem, *Enchanted Rose,* Adelaide confessed that "she felt in her heart the magic spell and her life blossomed out into full bloom." She found herself overwhelmed with love for the gifted tutor, but an aristocratic lady must be discreet, and love was translated into

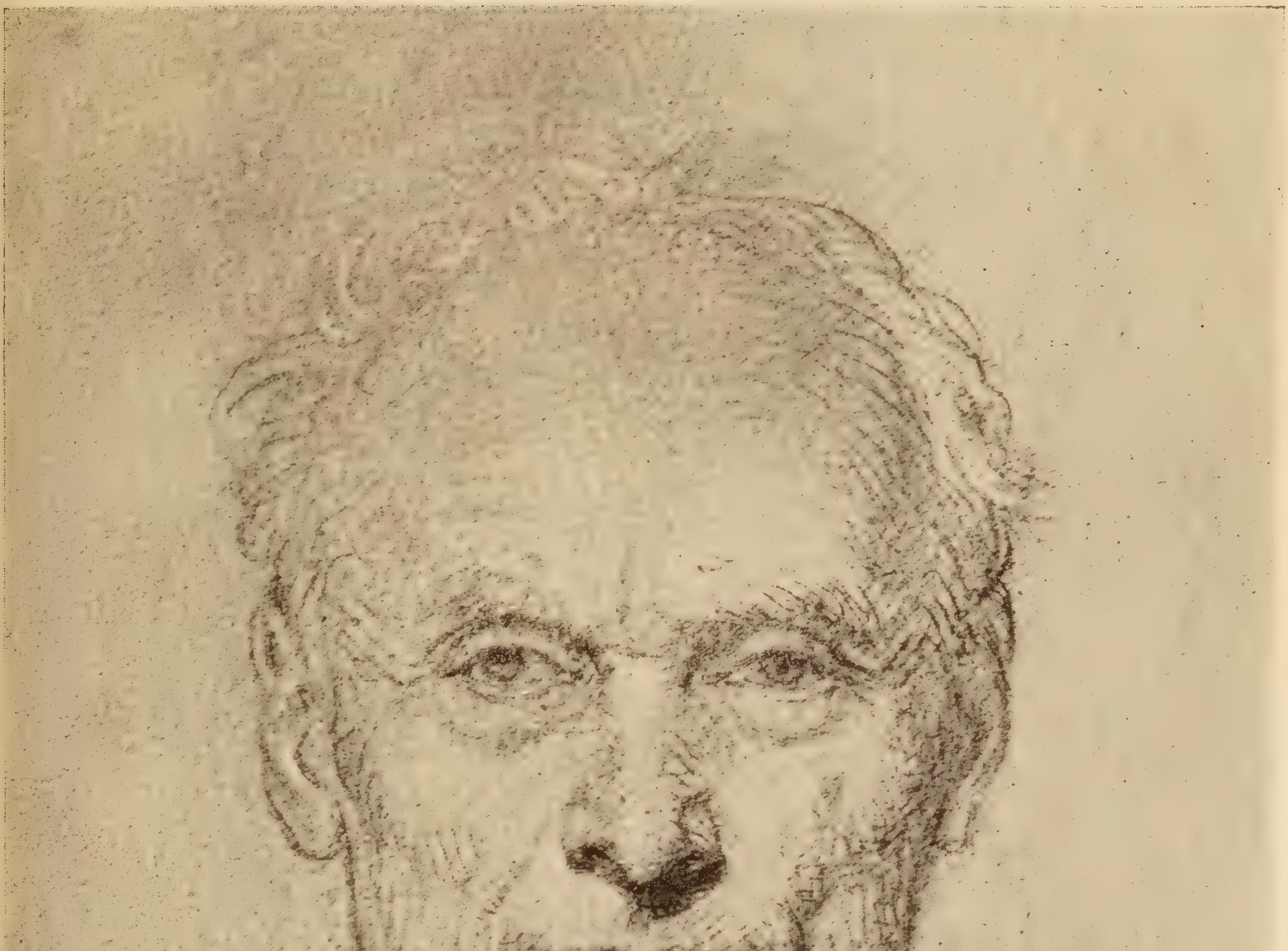
GOETHE
Portrait by Julie Gräfin Egloffstein, 1825.



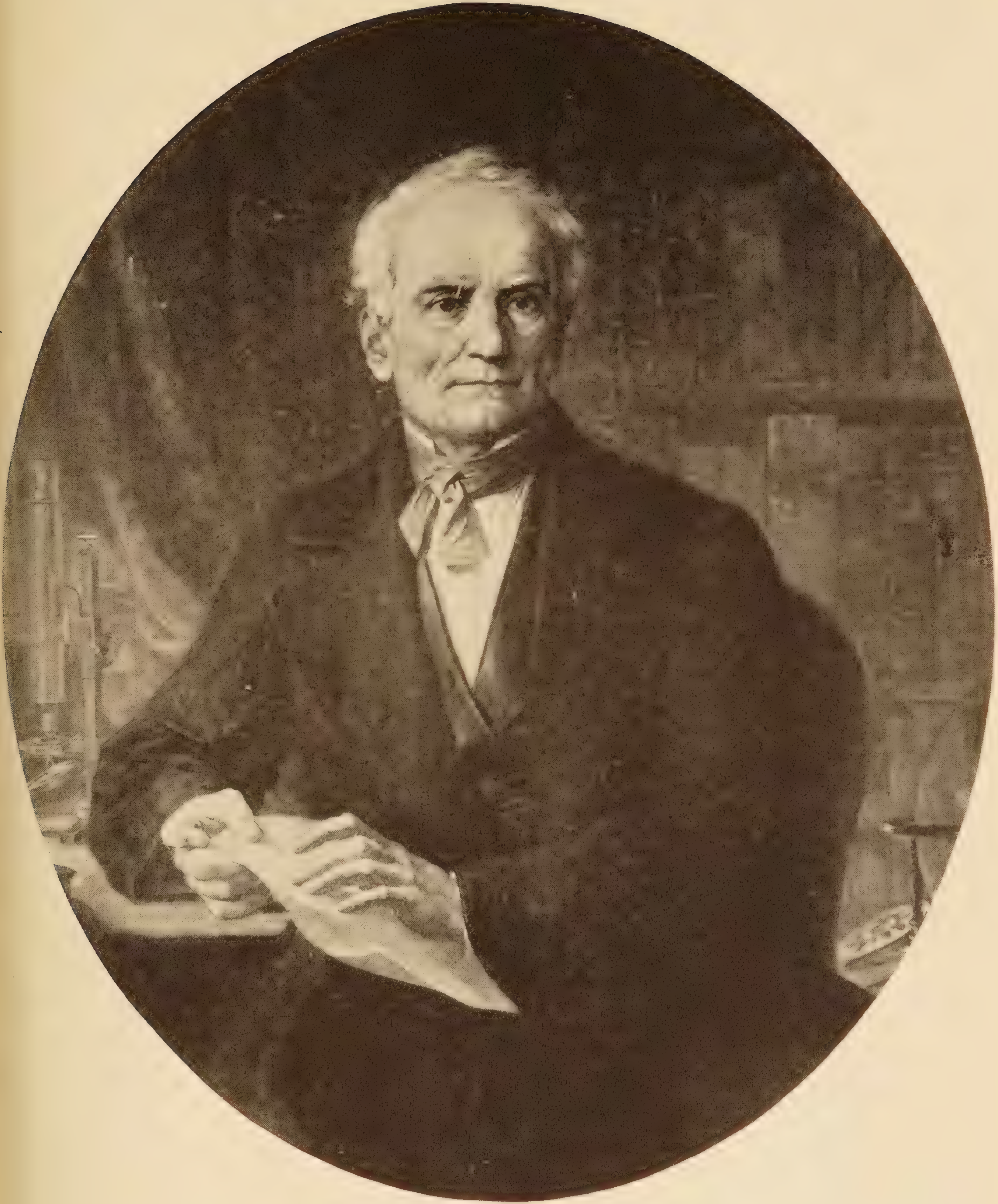
ALEXANDER VON HUMBOLDT



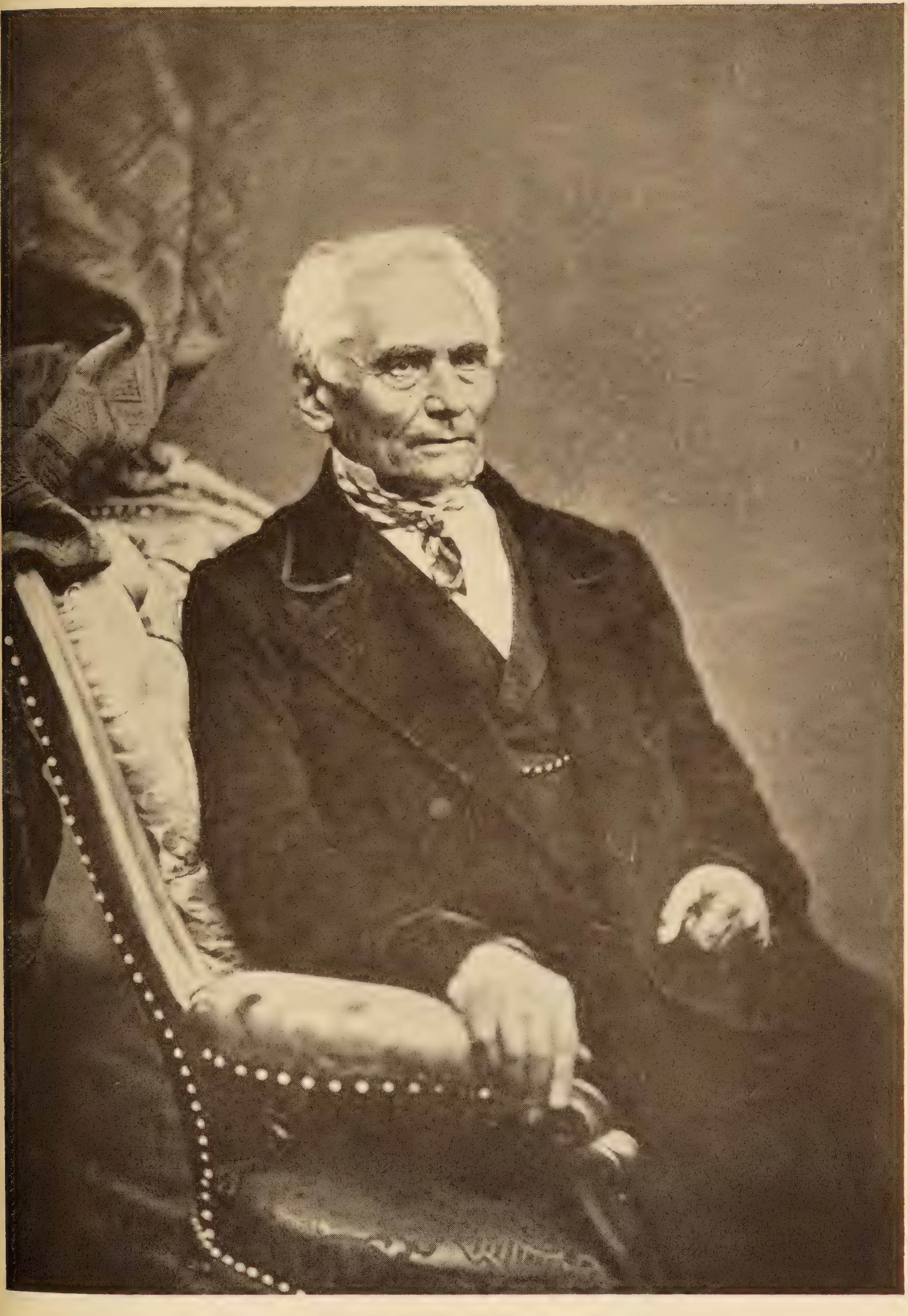
PURKINJE'S MICROSCOPE



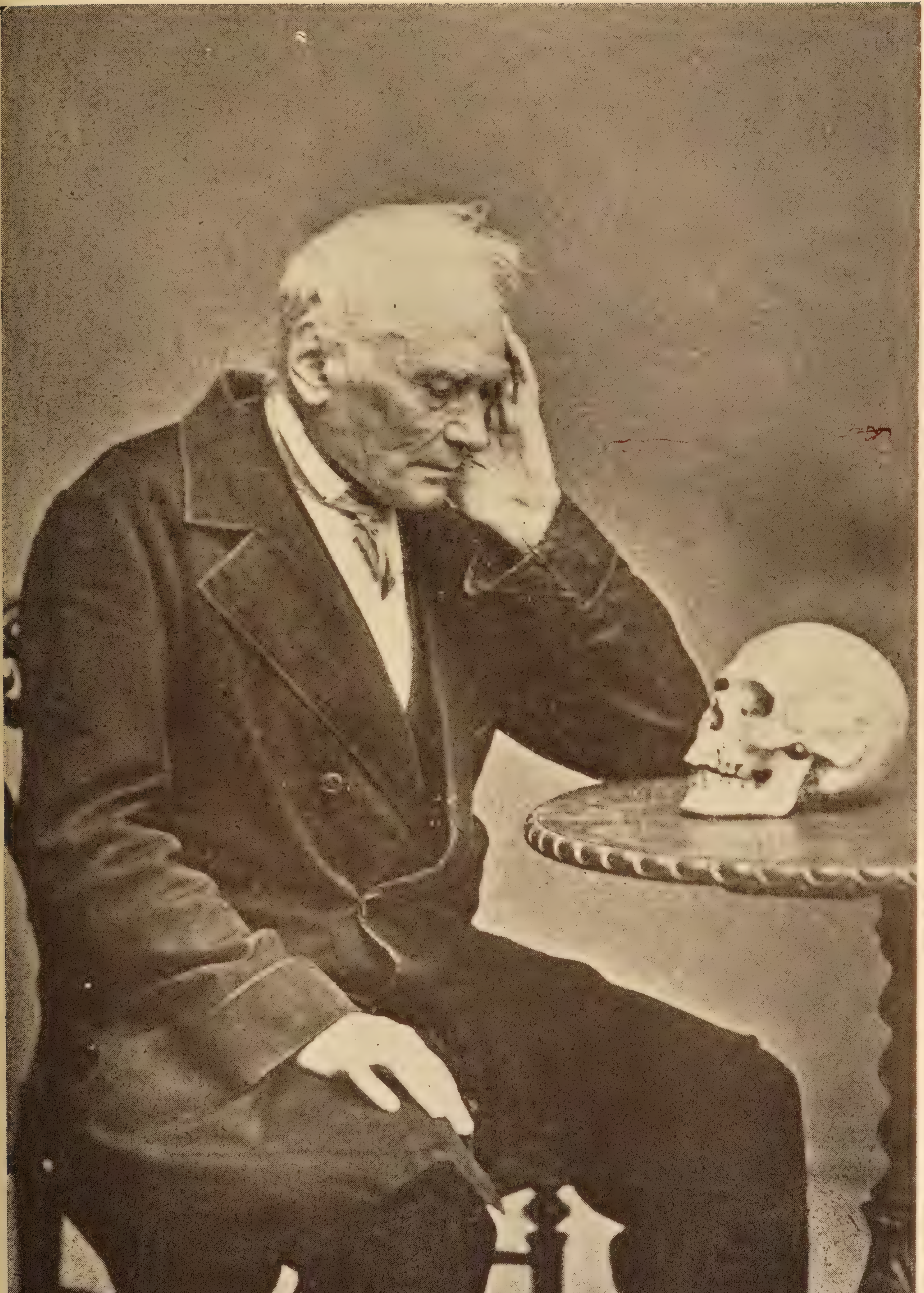
PURKINJE
By Joseph Mánes.



PURKINJE
Oil Painting by Peter Maixner.

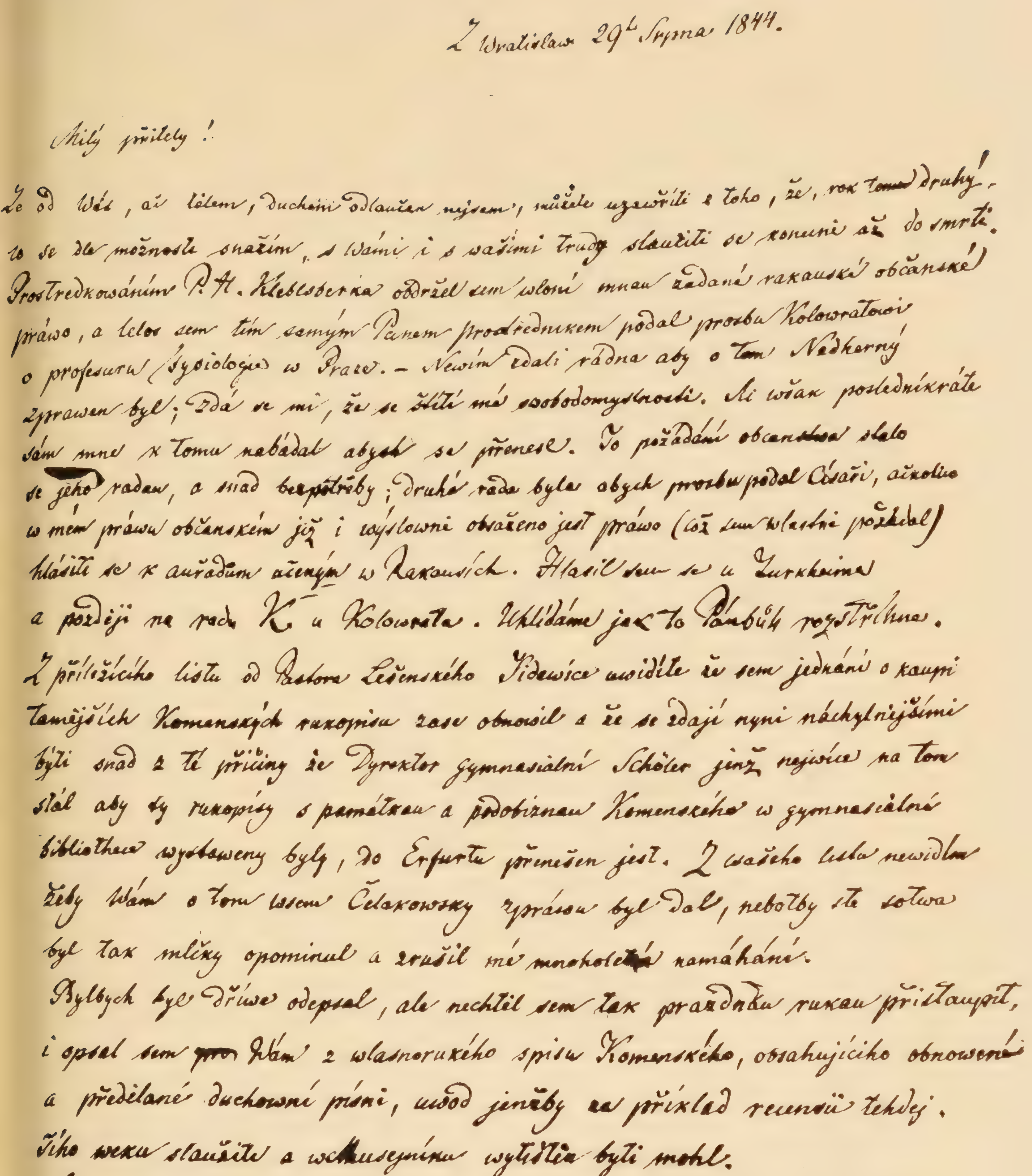


PURKINJE
A Contemporary Photograph.



PURKINJE

A Contemporary Photograph.



Z Wratislawi 29ᵗ Srpna 1844.

Milý příteli!

Že od Wás, ač tělem, duchem odlaučen nejsem, můžete uzawříti z toho, že, rok tomu druhý, co se dle možnosti snažím, s Wámi i s wašimi trudy slaučiti se konečně až do smrti. Prostředkowáním P. H. Klebelsberka obdržel sem wloni mnau žádané rakauské občanské práwo, a letos sem tím samým Panem prostředníkem podal prosbu Kolowratowi o profesuru fysiologie w Praze. – Newím zdali rádna aby o tom Nedkerný zpraweu byl; zdá se mi, že se štítí mé swobodomyslnosti. Mi wšak posledníkráte sám mne k tomu nabádal abych se přenesl. To požádání občanstwa stalo se jeho radau, a snad bezpotřeby; druhá rada byla abych prosbu podal Císaři, ačkoliw w mém práwu občanském již i wýslowně obsaženo jest práwo (což sem wlastně požádal) hlásiti se k auřadům učeným w Rakausích. Hlasil sem se u Turkheima a později na radu K. u Kolowrata. Uhlídáme jak to Pánbůh rozstřihne.

Z přiležícího listu od Pastora Lešenského Tidewice uwidíte že sem jednání o kaupi tamějších Komenských rukopisů zase obnowil a že se zdají nyní náchylnějšími býti snad z té příčiny že Dyrektor gymnasiální Schöler jenž nejwíce na tom stál aby ty rukopisy s památkau a podobiznau Komenského w gymnasiálné bibliothece wystaweny byly, do Erfurtu přenešen jest. Z wašeho listu newidím žeby Wám o tom wsem Čelakowsky zprášu byl dal, neboťby ste sotwa byl tak mlčky opominul a zrušil mé mnoholeté namáhání.

Bylbych byl dříwe odepsal, ale nechtěl sem tak prázdnau rukau přistaupit, i opsal sem ~~pro~~ Wám z wlasnoručního spisu Komenského, obsahujícího obnowení a předělané duchowní písni, uwod jenžby za příklad recensů tehdej. Tiho weku slaužiti a w Museyníku wytištěn býti mohl.

Jestli Museyní sbor ty rukopisy dokonce míti nechce, nechat se několik řádků po německu napíše k mému wywedčení. List Tidewica zase mně odešlete. Brzké odpowědi očekáwaje, waši manželku uctiwě pozdrawuje a dítky líbaje zůstawám

Wáš

upřímný Jan Purkyně

LETTER BY PURKINJE

Courtesy of his grandson, Professor Cyril Purkinje of Prague.

friendship. Twenty-two of her letters, written to Purkinje after his graduation, remain as evidence of this stifled passion; in the last of her correspondence, she tells him of her mother's death, reproaches him with not having answered her former letter, and while informing him that she has rejected a proposal, advises him to marry. Purkinje remained silent, but he did not forget, and in later years published Kačer's version of *Enchanted Rose.*

Before this edition appeared, Ernst Daniel August Bartels, probably the first professor of physiology in Germany, was called from Breslau back to the older university of Marburg where he had previously taught. Purkinje was among the candidates for the vacant chair, and was rejected by the professors who did not look with favor upon the unknown Slav. They did not reckon, however, with two great European powers who stood behind Purkinje, and since the combination of Goethe and Alexander von Humboldt was irresistible, Purkinje in 1823 went to Breslau in spite of the faculty. He found himself an unwelcome guest of the university, and his chair was not lined with velvet. Naturally he spoke German with a tinge of Czech accent, and the anatomist Otto sarcastically informed him that if he wished to be understood, he'd better lecture in Latin. Purkinje was not eloquent in expounding theories, and when he hinted that up to the present a lecturer in physiology was "merely a mechanism by means of which the theories of the old masters were repeated again and again," his classes dwindled in indignation and the faculty circulated a petition for his removal.

Later Purkinje stirred up more trouble by asking for a microscope. The authorities could not understand why a physiologist needed a microscope, and they sighed for the good old days of Bartels. There was the famous Bartels, becoming a Geheimrat and climbing to the Berlin chair; writing many books on *naturphilosophie,* medicine and theology; diagnosing all diseases with the most learned phrases and knowing enough to denounce such new-fangled notions as Laennec's stethoscope; and yet he never needed a microscope. If this were permitted to go on, the university would be cluttered up with apparatus and specimens, and the students would be occupied in performing experiments instead of reading van Helmont and Haller and Bartels. Evidently the arguments failed to convince Purkinje, for in an unoccupied corner of the college building he opened the first physiological laboratory. Had John Hunter tried to install his Museum in St. George's Hospital, he would not have aroused more opposition than Purkinje with his laboratary which seemed to his colleagues utterly useless in medicine. Moreover Otto, officious and esthetic, objected strongly to the stench. Purkinje solved the diffculty by transferring the laboratory to his own house, and thereafter he lived and dined and slept in the midst of physiological equipment—including the unavoidable odors. His wife was not supposed to complain, for she was Rudolphi's daughter.

In estimating the place of Purkinje in science, it should be remembered that he antedated the great experimental physiologists whose names are so familiar to-day. When Purkinje published his thesis in 1819, Johannes Müller was just entering the university of Bonn, Claude Bernard was a child of six, Brown-Séquard and Carl Ludwig were infants, Du Bois-Reymond was celebrating his first birthday, Brücke was uttering his first cry, and Helmholtz and Huxley were yet unborn.

The test of a scientist's character is his relationship to obscurer workers. Marshall Hall in announcing the existence of a system of excitosecretory nerves, did not mention Henry Fraser Campbell, for he had never heard of the American. Dr. Campbell, insisting that he had anticipated Marshall Hall and Claude Bernard in this discovery, forwarded to the English investigator a long letter and abstracts of his publications. The great Marshall Hall, then in his last illness, could easily have been too occupied to concern himself with the claims of the Georgia physiologist, and Campbell would have been forgotten. Instead, he sent a communication to the Lancet, giving the young doctor such full and generous credit that Campbell was encouraged to collect his essays into a volume which he dedicated to Marshall Hall "in high admiration of his genius, and in heartfelt acknowledgment of his liberality." This idyll of physiology is rare enough, while contests over priority are frequent, wordy, often vindictive and seldom settled. Instances in which teachers appropriate the labors of their pupils with inadequate recognition are not unknown even at the present day.

In this respect, Purkinje was particularly chivalrous and free-handed: he frequently incorporated his most important researches into dissertations which were signed by his students. Of course it was Carl Ludwig who developed this habit into a fine art. When Martin Barry, notable as the first to observe the union of the spermatozoon with the ovum, worked with Purkinje and showed him his essay on Fibre, Purkinje translated it for him and had it published in Müller's *Archiv.* Another pupil was Gabriel Valentin, who increased our knowledge of taste and touch, of nucleus and nucleolus, and whose *Manual of the Development of the Fetus* was the first systematic treatise on embryology—a mighty worker was Valentin in his day, ranging various fields, but his name has been almost submerged under the never-ceasing output of his successors. It was not the fate of Purkinje to leave behind him a school like Johannes Müller or Carl Ludwig, but we may say of him as Helmholtz said of Müller: "Whoever comes into contact with men of the first rank has an altered scale of value in life. Such intellectual contact is the most interesting event that life can offer."

Purkinje could have made his discoveries in a hayloft, yet academic life must have had its attractions, for he retained his chair for over a quarter of a century. His work was the most important produced in the Silesian university until the advent of Ferdinand Cohn, who after building the foundations of bacteriology at Breslau, helped Robert Koch lay the cornerstone there by his demonstration of the life-history of anthrax:

Cohn wrote the great news to Darwin, and the old biologist replied, "I well remember saying to myself, between twenty and thirty years ago, that if ever the origin of any infectious disease could be proved, it would be the greatest triumph to science; and now I rejoice to have seen the triumph."

Gradually the personal character and exceptional attainments of Purkinje gained recognition at Breslau. Students came to his classes and laboratory, his colleagues acknowledged his services, his small salary was increased to more respectable proportions, much-desired apparatus was secured, and in time the Prussian government erected for him a separate building devoted exclusively to physiology—this first Physiological Institute was opened November 8, 1839, and forty years passed before Berlin followed Breslau. Purkinje had reached his goal, but the fire of his genius had exhausted itself, and most of his great discoveries, the mere list of which still amazes us, had already been made in his own home. He admitted that "many promising investigations await the time when I shall have regained my lost love of work," but the fallow years proved that the ardor of youth had gone. He was indeed pleased at the tribute to his labors and science, although he no longer had the strength or enthusiasm to nauseate and sicken himself with huge doses of digitalis in order to study disturbances of vision. Moreover, administrative duties and requisitions for supplies are incompatible with research. It is pleasant to be a director or a dean, but who ever heard of a dean discovering anything? Purkinje now neglected his hard-earned compound microscope to translate the lyrics of Schiller into Czech.

The following letter written by Purkinje during his latter years at Breslau, exhibits his interest in his seventeenth century countryman, the great schoolmaster whose theological performances were unfortunate, but whose name will always survive in the history of education as one of the first rationalists in pedagogy. We are indebted for this letter to the courtesy of Purkinje's grandson, Dr. Cyril Purkyně, Director of the Státní Geologioký Ustav Československé Republiky:

Breslau, August 29th, 1844.

My dear Friend:

That I am with you in spirit, although far away, you may judge from my effort for the past two years to join you and share with you your vicissitudes until death. With the assistance of Mr. P. H. Klebelsberk I have obtained Austrian citizenship for which I applied last year, and this year I have presented through this same gentleman my request for the chair of physiology at the University Praha, to Count Kolowrat . . . I doubt whether it would be advisable to inform Mr. Nádherný regarding this step, as he seems to shun my freethinking, although he himself has recently suggested to me to apply for transfer. My petition for citizenship has been presented upon his advice, and perhaps without need. His second suggestion was to send a petition to the Emperor, although my citizenship definitely includes my right (for which I have asked) to apply for appointments to the institutes of learning in Austria. I presented myself to Türkheim and later upon the advice of K. to Kolowrat. We shall see what the result will be.

From the enclosed letter of the Rev. Sidewice, Lĕsno, Prussia, you will note that I have re-opened negotiations for the purchase of the manuscript of Comenius and that they now seem to be more approachable, perhaps because of the fact that the Gymnasium Director, Mr. Schöler, who was the one who chiefly insisted to retain and exhibit the manuscript together with the relic and portrait of Comenius in the gymnasium library, has now been transferred to Erfurt. I do not see from your letter that Čelakovský could have given you any information about it, as you certainly would not have been silent on the subject and thus frustrated my many years' effort.

I would have replied to your letter earlier, but I did not want to come to you empty handed and so I copied for you from Comenius' own manuscript, re-written and re-edited church songs, introduction, which might be published in the Musejnik as an example of writing of that time.

Should the Museum Committee definitely not wish these manuscripts, please have them send me a few lines in German for my verification. You will kindly return to me Sidewice's letter.

I look forward to an early response from you and with my respectful greetings to your wife and kisses to your children, I am

Your devoted
Jan Purkyně

As previously stated, Purkinje's first work was in physiological optics. Thrice he wrote his name in this field: Purkinje's figures, Purkinje's images, and Purkinje's phenomenon. A bibliography of the contributions to these subjects during a century would show how large a number of investigators received their impulse from Purkinje. The work of Purkinje was germinative, for even if it consisted of only a few paragraphs, it proved reproductive. His method of lighting the retina, his measurements of the curvatures of the lens and cornea, his studies of the refracting surfaces of the eye with mirrors, not only anticipated the ophthalmoscope of Helmholtz, but made it inevitable.

The name of Francis Galton is usually associated with the foundation of finger-print identification, but seventy years earlier, Purkinje wrote: "The wonderful arrangement and design which are on the palm of the hand and upon the sole of the foot, and especially the little hollows on the fingertips, the papillary lines, command our attention." He then proceeded to describe with accuracy the unchanging character of finger-prints, illustrated with various figurations. His pioneer work is of value to all criminologists, and the English penitentiary inspector, Major Arthur Griffiths, author of the Chronicles of Newgate, writes: "The permanent character of the finger-print was first put forward scientifically in 1823 by J. E. Purkinje, an eminent professor of physiology, who read a paper before the university of Breslau, adducing nine standard types of impressions and advocating a system of classification which attracted no great attention." With G. Rosche, we may well call Purkinje the old master of dactyloscopy.

Most pre-Virchovian workers, including Purkinje, are rather roughly handled in the *Cellular Pathology,* but Virchow credits Purkinje with having devised the term corpora amylacea; he also introduced the terms enchyma and cambium and protoplasm and others—almost reminding us of Walther Flemming who in a single year increased the nomenclature of cytology with mitosis, amitosis, karyomitosis, dyaster, karenchyma, net-knot, spireme, mitome, karyoplasm, and interfilar substance. Richard Mead, relying on the experiments of Galen, felt safe in swallowing the poison of vipers, but Purkinje broke new ground in some of his self-experiments with belladonna, camphor, digitalis, opium, stramonium, and turpentine.

Every investigator of the first rank has conducted a host of minor researches, and among Purkinje's innumerable ones may be mentioned: an early paper On the World of Dreams, now over a century old, which should be read to-day in the light of Freudism; the contribution to acoustics, On Tartini's Tones; his auscultation experiment, by which he was able to determine the points of rest and motion of a vibrating plate, without employing Chladni's sand; his work on rhizopods, the nautilus, and embryology of the tadpole; his original description of the peculiar formation of the skin of cucumber plants; and his observations of the methods of fertilization in the plant world.

More important investigations, and belonging chiefly, but not exclusively, to his first sixteen years at Breslau, were: his contribution to photometry; his observation that deaf-mutes can hear through the bones of the skull; his experiments upon the production of vertigo which paved the way for the knowledge of nystagmus; his work with Pappenheim on artificial digestion which antedates Schwann, including the demonstration of the dissolving power of acidulated infusion of pancreatic juice; his researches with Valentin on ciliary epithelial movement and the explanation of its independence of the nervous system; his original descriptions of bone, cartilage, blood-vessels, gastric glands, and special organs; his discovery of the sudoriferous glands and their ducts; of the flask-shaped Purkinjean nerve-cells with their axones and branching dendrites which form the characteristic features of the cerebellum;

and of the Purkinje fibers in the cardiac muscle. In microscopy he was the first to use the microtome, microphotography, Drummond lime light, glacial acetic acid, potassium bichromate, and Canada balsam.

There is much confusion in regard to discoveries of the nucleus: standard general and medical dictionaries give incorrect information, and Locy, although he devotes much space to it, in no way clarifies the subject. We have frequently read the statement that Purkinje in 1825 discovered the nucleus of the human ovum; this is manifestly impossible when we remember that the mammalian ovum itself was not discovered until two years later by von Baer. What Purkinje did discover was the nucleus or germinal vesicle in birds, announcing his find in the *Gratulationsschrift* to Blumenbach; he was likewise the first to use the term protoplasm for the embryonic formative substance. Misstatements concerning Purkinje are prevalent: for example, Littré, in his classic Dictionnaire de Médecine, actually refers to him as *anatomiste hongrois;* while Dorland, after thirteen editions of his popular dictionary, repeats this error, and gives the date of his death as 1850! A man whose connection with the cell-doctrine was as intimate as Purkinje's, deserves more accuracy on the part of lexicographers. If Schleiden and Schwann are the fathers of the cell-theory, Purkinje is at least its great uncle, for prior to Schleiden and Schwann he taught that organs consist of cells and nuclei, and suggested the probable identity in the structure of animal and plant cells. In this, however, he was not without various forerunners.

Since the universal cell is now recognized as the basis of life, we should be familiar with a chronology of cytology, and many of the earlier dates and facts will be found in that storehouse of biological knowledge, Johannes Müller's book. It is a pity that this great manual of physiology should have been superseded by later productions, for in numerous respects it has never been equaled. Even to-day, with a little editing and some footnotes, it would serve admirably, for as far as we recall, the only passage that is entirely obsolete is the following: "Woman is distinguished by her modesty, meekness, patience and amiability; by her readiness to sacrifice her own good and herself for the sake of others; by her tenderness, sympathizing disposition, and piety. The field of her activity is her home and family."

If it be asked why Purkinje spent twenty-six years in a foreign country, the answer is simple: for the same reason that Kaspar Wolff, the founder of modern embryology, journeyed from his native Berlin to spend his last thirty years in Russia. Purkinje had applied for a chair in Prague, but they were filled with long-lived occupants, or the authorities appointed what Huxley would call a "safe nobody." Wolff may have grown accustomed to Catherine the Great, but in spite of his success at Breslau, Purkinje felt an expatriate, and cast many longing glances toward his own soil—more than once he sought an opportunity for returning, but Bohemia was not yet ready for her greatest son. Purkinje was a true Czech, and Tyl's *Kde domov můj* stirred him as if he were a gymnasium student. Fortunately for his reputation, he was not guilty of the extravagances of the great Swedish anatomist, Olof Rudbeck, who ignoring his real discoveries, regarded the *Atlantican* as his chief work—huge folios claiming that after Noah's flood, the land which Japheth sought and found was Sweden, the Almighty's favorite spot on earth. How men of intelligence can do these things, is really beyond comprehension.

Purkinje finally returned to Prague as professor of physiology. "Well do we remember," says a Czech writer, "how Purkyně's coming in 1850 was celebrated not only in Prague, but in all the provinces." Old and famous, he was no longer compelled to fight for a laboratory; the Austrian government gave him a splendid one, with a capable assistant and an adequate salary. Purkinje was over sixty, and he proved that apparatus alone cannot make discoveries.

It would be entirely erroneous, however, to believe that he had retired, or that his intellectual activity was at an end. The days of his epochal discoveries were indeed over, but he had made enough for an entire institute of research. He now busied himself with Czech politics, and whoever did that in the mid-nineteenth century was much occupied—he was elected to the senate and served with exemplary diligence. The pen is often the staff of age, and Purkinje wrote copiously: he was a founder and editor of the journal of natural history, *Živa,* and for several years one of its principal contributors. He vitalized the *Journal of the Bohemian Museum,* and his popular essays in the Bohemian language stimulated interest in nature. He continued to develop the ideas of Pestalozzi, and discussed the establishment of orphan asylums from a scientific standpoint. Josef Klika was able to produce a lengthy monograph devoted exclusively to "Purkinje as a Pedagogue."

There are few scientific workers of the scope of Purkinje of whom so little is generally known. His name does not once occur in Baas, although that thick and valuable volume is at times overloaded with forgotten names. If an explanation is sought of this and similar omissions elsewhere, it is found partially in the fact that Purkinje, by returning to Prague and not identifying himself with the Vienna school, stood apart from the main stream of German medicine—indirect but potent testimony of the influence of the Vienna school. Distinguished medical travelers, such as Richard Bright and those who followed in his footsteps, have left their impressions of medical Vienna, but Prague was out of the way.

It would not be correct, however, to cite Purkinje as an example of genius overlooked by his contemporaries and neglected by posterity. Even when he ceased to keep up with the progress of physiology, and younger giants overstepped his own frontiers, he was not disregarded. In fact, to read nice things about himself he was not obliged to follow the usual custom and wait for the obituary notices. In 1859, the distinguished Eiselt published an accurate analysis of Purkinje's work, occupying twenty printed pages; in 1867, an appreciative biographical sketch appeared in *Světozor,* concluding with the passage:

> . . . the greatest reward and one which is dearest to him is the unbounded affection with which our entire nation clings to him, the proof of which was apparent last summer when he passed through some parts of the land. Wherever he appeared citizens endeavored to honor him; the day of his coming was a day of celebration. He is truly not only honor-deserving, but a really lovable personage. Whoever sees him must love him. He has lived eighty years, and certainly not in leisure, but he still walks with vigor and enjoys splendid health: it seems as though nature herself wishes to mark her ardent admirer and worker.
>
> His faculties are excellent, and he who would count upon his "aged memory," would be much surprised. His humor retains its original freshness; he likes to be in company and contributes to conversation his characteristic wit. He has never known idleness and despises it now; he must be active, always, either in his own branch, or he finds other work and pursues it with youthful enthusiasm. Only recently he translated the Evangelium of Sallet, and Barthriari's Book of Love; he edited the original Austria Polyglotta, and learned the difficult Magyar tongue; he practices his violin, etc.
>
> We cannot do better in taking leave of this noble and beloved son of our nation than to call heartily *Mnogaja leta!* (many years).

In 1868, the Bohemian Medical Society at Prague published a quarto—*Quod bonum, felix, faustum fortunatumque sit, Joanni Ev. Purkyně, diem semisaecularen x. dec. 1868 summorum in medicina honorum in alma antiquissinaque universitate Pragena celebranti gratulatur. . . .* The obituary notice in the Proceedings of the Royal Society of London, after summing up his unusual achievements, states: "In 1848 he attended the meeting of the Slavonic races in Prague, and was present at the celebration of the five hundredth anniversary of the foundation of the University, when the degree of doctor of philosophy was conferred upon him. A long-cherished wish to be enabled to pass the remainder of his days in his native country was gratified. . . . His election as a foreign member of the Royal Society took place in 1850. He was corresponding member of the French Institute, member of the academies of Vienna, Berlin, and St. Petersburg, and of many other learned societies. He retained his vigor of body and mind up to the last days of his life. His death, after an illness of no long duration, on the 28th of July, 1869, was mourned by every class of society in Bohemia."

When we think of that trinity of astronomers, Horrocks, Gascoigne, Crabtree: Jeremiah Horrocks, discovering the Transit of Venus across the Sun, and in terror that his Sabbath duties as a parish curate would prevent him from observing this phenomenon; practically a beggar, without leisure for science, in broken health, dead at the beginning of his twenties, and from his grave teaching a Newton; his friend, William Gascoigne, inventor of the micrometer, slain in his youth at Marston Moor, leaving his work unfinished; his other friend, William Crabtree, corrector of the Rudolphine Tables, likewise disappearing early from the banquet of life in an unknown manner—we are thankful that Purkinje, like Goethe and Humboldt, was spared by fate to write Finis to his labors. At the time of his death, Purkinje was in his eighty-second year. Happy is the pioneer who becomes a patriarch, and at whose bier a grateful and sorrowing nation bows its head.

Now that Purkinje's beloved Bohemia has emerged as an independent country, the Republic of Czechoslovakia is adding new laurels to the name of Purkinje. Kamil Lhoták v. Lhota, professor of pharmacology at Prague, edited a handsome volume of Purkinje's original monographs. Paul J. Hanzlik of Stanford University informs us of the sad fact that Dr. Lhoták died young of gastric carcinoma, but no doubt other devoted hands will carry on the work. Professor Hanzlik has also directed our attention to two volumes, recently issued by the Czech Medical Society, of the personal correspondence of Purkinje, containing letters sent to him from a considerable number of people in all walks of life and from all over Europe—the nobility, statesmen, publicists, poets and scientists.

Foreign countries have also not forgotten him. E. Thomsen of the university of Copenhagen, published in the *Skandinavisches Archiv für Physiologie* a study of Purkinje for which he received a gold medal. In a personal letter to Henry Jerry John of the Cleveland Clinic, Dr. Thomsen writes: "There does not exist any reprint of my article on Purkinje. That work was written when I was a poor student, unable to buy reprints!"—here, then, is an important function for the photostat. Dr. John is the chief Purkinje student in this country, and after several years of effort has collected, in many volumes, practically everything that has been written by and about his illustrious countryman. We cannot permit this occasion to pass without acknowledging our indebtedness to Dr. John for placing at our disposal his patiently-accumulated data and the illustrations which adorn this essay; when we add that Dr. John himself is planning a biography of Purkinje, yet readily granted prior use of his material, his generosity will be realized. A definitive biography of Purkinje, sixty years after his death, is much desired, for his influence lives: the Quarterly Cumulative Index Medicus for 1928 seems to contain more references to Purkinje and his work than to any other physiologist of his era. It is the glory of Purkinje that he holds a foremost place among the investigators who found physiology a speculative subject and left it an experimental science.

Hradčany Hill with its castles and cathedrals has seen a thousand years of battle, and for centuries the waters of Vltava have been reddened by intolerance. Towers upon towers, and those black Towers of the Abandoned. This is the story of Prague, and it is also the story of every capital in Europe. Climbing the Petřin, looking over Prague to the Giant Mountains, and from the heights of Moravia's frontier to the Bohemian Forest, how magnificent would be the view if we did not know that every inch of soil was blood-stained. Prague is beautiful—Humboldt calls it the most beautiful inland town of Europe—and to enter this historic threshold would be a feast for the soul, could we but forget the aggressions of kings and the endless strife of conflicting sects in the name of the Prince of Peace. . . . That wonderful old clock with the moving apostles and the crowing cock is still ticking the time—the clock that told the hours before Columbus set sail for America and immortality. Those countless moss-grown tombs in the ancient and crowded burial-ground of the Jews—under the elder-trees, the teacher tenderly surrounded by his thirty-three scholars. To Prague in his broken years came that master of the moon, Tycho Brahe, and here are his remains and relics; after him followed a pock-marked vagabond from a public-house to capture a planet for a mad emperor—John Kepler's *Commentaries on Mars* helped fulfil the prophecy of Libussa: "I see a city whose glory touches the stars." Monuments of monarchs and warriors—several recently removed from the public squares and hidden in museums. Let these mediæval spirits disappear forever, until there glows across humanity's sky the sunrise that shall never set, burning away the barriers that divide the human race, revealing at last to the children of Mother Earth that none can be aliens and all are brothers. . . . Wandering through the streets of Prague, in the aimless yet interested fashion of tourists, we came suddenly upon a simple house with a plain tablet stating that this was the house of Purkinje. To the student of science this is the most inspiring spot in all Prague, for here lived the man who, standing humbly before truth, read many of nature's secrets, and thus enlarged the human horizon.

(1804–1881) (1810–1882)

SCHLEIDEN AND SCHWANN

With that grand movement of the biological sciences that began about 1838, and of which we to-day contemplate the superb bloom, two names are inseparably connected—Schleiden and Schwann.

Leo Herrera.

Among the milestones of modern scientific progress the cell-theory of Schleiden and Schwann, enunciated in 1838–39, stands forth as one of the commanding landmarks of the nineteenth century.

Edmund B. Wilson.

XVIII

SCHLEIDEN AND SCHWANN

Matthias Müller was a shoemaker, which means that he was poor but honest. Not everyone in his neighborhood was well-shod by any means, and it is absurd for a shoemaker to be idle amongst barefooted people, but this is a mystery of political economy which we must leave to the disciples of Comrade Marx. Had it not been for Napoleon's soldiery who overran the country and needed their boots mended when they visited the farmers' daughters, Müller's wife would have made few visits to the baker. And as all cobblers obey the injunction to replenish the earth, Matthias Müller had a brood to feed.

Little Johannes, for instance, forgot he was a poor man's child, and ate with a royal appetite. Johannes was a sturdy self-assertive lad who wandered all over the town on his bow-legs. Sometimes his mother couldn't find him, and then she was sure he was drowned, for the Müllers lived at Coblenz —where the river Rhine meets the waters of the Moselle.

Once Johannes walked a long way through the vineyards till he reached an imposing rock at which a group of people were looking. A few of the women had notebooks in their hands, and one of the men was standing in front of the others, pointing with a cane and speaking: "Very long ago, as the twilight came down from the hills, a water-nymph would appear on this rock, and she would sing soft and low until darkness was overcome by light, and day drove the gray mists from the valley. So beautiful was she, as she sat there, combing her golden hair by moon-shine, and so sweetly she sang her plaintive lullaby, that whenever a boatman heard her voice he lost his senses, and swooning with desire he steered toward the maiden. But already when he dreamed of possessing her, he would strike against the reefs and perish. The bold Roland, the son of the Palatinate count, heard of the enchantress, and determined to see her. He took an old sailor with him, and as they rowed towards the cliffs—" here the guide spoke confidentially, and Johannes could hear nothing more. But the Müllers did not believe in the Lorelei, for they were good Roman Catholics and had enough legends of their own.

When the boy's biceps grew shapely, his father planned that Johannes also should work with leather, but not as a cobler—as a harness-maker. He would fashion the winkerstraps and the breeching, the check-rein and the belly-band. But the mother demurred—the child was so bright—all the neighbors said so—if they could only send him to the Sekunden Schule so he could become a priest—perhaps they could manage somehow? Matthias Müller sighed and shook his head mournfully —but Johannes was sent to school for all that.

The sons of scholars yawned over their books and tried to bribe the shoemaker's child to do their lessons. The schoolroom was to be Johannes Müller's domain for the rest of his life. Deciding to study medicine he entered the University of Bonn, and at the age of nineteen he secured a prize for his researches into the respiration of the fetus. At twenty-two he was appointed privat-docent; at twenty-five he was extraordinary professor; three years later he was full professor.

In 1833 occurred the death of the distinguished Rudolphi of Berlin, and Müller wrote to the authorities, "With the exception of Meckel no one in Germany can fill this post as well as I." Evidently this was the same Müller who a few years previous, when wooing a girl, wrote her a poem declaring that as a marriage settlement he offers her no money but an immortal name. But folks were not in the habit of saying to Johannes Müller, "You are conceited." Without delay he won Anna Zeiler and Rudolphi's chair.

For twenty-five years he remained Professor of Anatomy and Physiology at Berlin, and during that quarter of a century he was probably the most conspicuous man in the scientific world. Nearly every worker who added a stone to the structure of German science received instruction and inspiration from this great teacher. No single discovery of paramount importance is associated with the name Johannes Müller, but the jewels that he could exhibit were Virchow, Brücke, Henle, Wagner, Helmholtz, du Bois-Reymond, Claparède, Ludwig, Schwann, Volkmann, Reichert, Lachmann, Vierordt, Troschel, Kölliker, Remak, Lieberkühn, Haeckel.

The spirit that animated Müller's lecture-room recalls the days when Plato stood in the Academic Grove, and Aristotle pondered in the Lyceum, and Epicurus philosophized in the Garden, and Socrates walked the market-place followed by his pupils. Students flocked to Müller not merely to pass examinations and receive a diploma—they came with full hearts, in a glowing fervor, like pilgrims to a shrine. To work under Müller was not an incident in one's medical career: it was an epoch never to be forgotten. So magnetic was his personality, a glance from his splendid eyes made such a lasting impression, that in an earlier century Müller could easily have become the founder of a religion. As it was, many felt and claimed that there was the stamp of the supernatural upon him. Emerson wrote an essay on Character, but Johannes Müller lived it.

Only once did Müller come in conflict with his pupils, and then the master's voice fell on unheeding ears. Then the youths who had sat at his feet rose up and deserted him. The students who had been so proud to work in Müller laboratory, left the markings on the myograph unvarnished, and the busy reagent bottles were all stoppered—till their necks were incrusted with salt and dust. This was in 1848, when an outraged world revolted. The people defied the tyranny of kings, and the red flag was unfurled in the whirlwind. A pike seemed to be in every hand, and Comrade sanctified every lip. In what hopes, in what dreams of freedom did Young Europe indulge! Such high days do not come again. The lads decided to test theories, not on laboratory-desks, but on the barricades. Müller's Manual of Physiology was forgotten while they read the Communist Manifesto. They sang aloud, not college-songs, but revolutionary hymns. They were ready to take examinations and answer the questions, not in ink, but with blood. They did not stir weak chemicals in frail beakers, but with gunpowder they shook thrones.

But the shoemaker's son set his face against the democratic passion. Müller was the director of the Berlin Museum, and in the clash and shock he feared a pathologic specimen of a guinea-pig's endgut might be damaged. Property seemed more sacred to him than the liberties of nations. An official position is gag and gyves. Only he who is free from purse and responsibility can afford to tell the truth. Decorated academicians in the assembly-hall are never as honest as carousing bohemians in the café. Respectability has its penalties.

The matchless vision of the ideal Republic, which in those days uplifted the souls of Herzen and Petőfi and Mazzini and Garibaldi, was not discerned by Müller. One of the rebels—Virchow—has told how, day and night, Müller remained at the museum, ever on guard; he tore down agitating placards; he ventured with personal danger among the students, and on the day of the great citizens' parade the unhappy Professor, with his own hand, seized and tore away the black banner which was stretched across the balcony of the university building.

But every one felt that although the Director was mistaken, he was not dishonorable, and when the aspirations were crushed, and the uprooted thrones rested again on the twin-pillars of militarism and clericalism, Müller got back his pupils.

No anti-vivisectionist would imagine he could find comfort from the greatest physiologist of the nineteenth century, but in a panegyric on Rudolphi, Johannes Müller spoke these words: "Rudolphi looked upon physiological experiments as having no relation to anatomical accuracy, and it is no wonder that this admirable man, who had at every opportunity expressed his abhorrence of vivisection, took up a hostile position against all hypotheses and conclusions insufficiently established upon physiological experiments. . . . We could have failed to share his righteous indignation had we not seen how many physiologists were using every effort to reduce physiology to an experimental science by the live dissection and agonies of innumerable animals, undertaken without any definite plan, and yielding often insignificant results."

During Müller's first year of medical studies he was starting on a journey by horseback to Arrthal. Along the roadside he espied a pregnant cat, and remembering that he was investigating the respiration of the fetus, he chased the animal till he captured it, and by means of Cæsarean section deprived it of its young. It is questionable if the mature man would have repeated the experiment of the nineteen-year old student, for—as the words quoted above plainly indicate—Müller grew averse to vivisection, and seldom would put a knife into a living warm-blooded animal.

Because of Müller's dislike for the purely experimental part of his science, he became addicted to the descriptive portion of it, and published an enormous amount of strict morphology. Week after week and year after year he enlarged the boundaries of structural anatomy, and although Müller could rule the double domain of anatomy and physiology, no one else could, and at his death his biological kingdom—like Alexander's empire, as du Bois-Reymond said—was divided among his followers. Müller's chair was split into three: du Bois-Reymond took physiology, Virchow took pathological anatomy, and Reichert took morphology.

It is our conviction that the result has been unfortunate. Anatomy, divorced from Physiology, is sterile; yet generations of students have been forced to cohabit with her till they echoed a yawning Amen to Dr. Conan Doyle's dictum: "For him who has mastered Gray's Anatomy, life has no further terrors." Because of the stress laid on morphology, to-day the entrance to the temple of medicine is by the narrow door of memory, and not through the broad gate of understanding.

Not mental alertness, but an extraordinary amount of *sitzfleisch* is required to be able to remember in detail the surfaces of the petrous portion of the temporal bone. Cramming attracts the grind, but repels the genius. Emphasis should not be laid on those topics which are expected to be forgotten as soon as the quiz is over. Lifeless phraseology and superfluous terminology do not constitute a science. The present method of teaching anatomy, the presentation of a mass of technical description, gross and histological, which must be learned by rote, is not calculated to stimulate the contents of the cranium. The long, dry, useless course in osteology should be abolished, structure should not be taught without reference to function, and the chairs of anatomy and physiology should again be united under a single scepter.

The development of embryology in the eighteenth century was retarded by the preformation theory which held that on the last day of God's labor he created two hundred thousand millions of human beings in embryo and neatly packed them in the ovaries of Eve, from which they were unfolded generation after generation.

In 1759 a young man, working for his degree, attacked this notion and advanced the doctrine of epigenesis. But Haller, the foremost professor of the age, was a preformationist, and between this potentate of physiology and the unknown Kaspar Wolff there could be no argument. Haller simply laughed, and no one read the young doctor's thesis. When Meckel translated it in 1812 he had to wipe from its covers the dust of half a century. So effectually was the light of Kaspar Wolff quenched by the Hallerian snuffers that to-day not a single portrait of the founder of epigenesis is extant. No man knows how the greatest embryologist of the century looked.

After Albrecht Haller came Cuvier who was much more mischievous in combating new ideas. During the many years in which his influence was supreme, Cuvier was a veritable barrier obstructing progress. It is a matter for regret that his early ambition was frustrated and that he failed to receive an appointment in the seminary, for he would have done less harm in theology than in science. Furthermore, as a priest he would not have been the foster-father of Richard Owen and Louis Agassiz—two eminent gentlemen who had unusual faculties for committing blunders and corresponding propensities for persisting in them.

Johannes Müller, because he likewise covered the whole field of biology, has often been compared with Haller and Cuvier, but he was the noblest of the three: he permitted contradiction. He did not use the key of authority to lock out a young discovery. Müller lived to see much of his work remodeled by his pupils, but it is his eternal glory that he never attempted to hinder the advance of truth.

> Who loves not Knowledge? Who shall rail
> Against her beauty? May she mix
> With men and prosper! Who shall fix
> Her pillars? Let her work prevail.

Among Johannes Müller's favorite pupils was Theodor Schwann. Schwann's parents knew nothing of the limitation of offspring, and had a dozen more children besides himself. His early education was received at the Jesuit Gymnasium of Cologne. It is curious that men should be so touchy about their theology; if they chose one form of religion in preference to another after reaching years of maturity there might be some reason for their standpoint, but nothing is more accidental or artificial than our religious beliefs. Our creeds are prepared for us while we lie in our cradles. If Schwann had not been born in the old Catholic Rhineland and had not received his first instruction from the Jesuits he certainly would have felt no reverence for the pope's toe. Even from Russian prisons men have been known to come forth uninjured, but no one emerges from a Jesuit's cell unscarred. Laennec and Pasteur were Catholics because they were educated to be Catholics, and Faraday and the chemist Wurtz were Protestants because their parents were Protestants, and ancient Livy believed in Romulus and Remus because he had been thus taught to believe, and in the *Philosophical Dictionary* of Voltaire is a story of an Arab who besides being a good calculator, was a learned chemist and an exact astronomer, and nevertheless believed that Mahomet put half of the moon in his sleeve. Religion is a matter of geography. A man's faith is mapped out for him by his good grandmother, and yet he takes it all so seriously.

> By education most have been misled;
> So they believe, because they were so bred;
> The priest continues what the nurse began,
> And thus the child imposes on the man.

Schwann's relatives expected him to be a clergyman like his older brother Peter, and he himself had inclinations for the pulpit, but not being quite decided as to what profession he would follow, he enrolled in the University of Bonn in the class of philosophy, a mixed course which included some instruction in mathematics and science. He thus became a pupil of Johannes Müller, who was experimenting at the time with the spinal nerves of frogs, and when the master said, "Herr Schwann, you may cut the anterior root," the youth's destiny was fixed. Müller, the human lodestone, had attracted this student as he did hundreds of others.

Theodor Schwann made up his mind to become a scientist. For two years he studied medicine at Würzburg, then came to Berlin, where he again found Müller, and became, as we have already said, one of his helpers. Schwann's thesis for the doctorate was an embryological subject, and of course the chick was the medium employed. We may almost say that if it were not for the chick there would be no science of embryology—which sounds like Huxley's remark that frogs were invented for biological experiments. When the post of Assistant in Anatomy fell vacant, Müller offered it to Schwann. The duties were strenuous, but fortunately he did not have to lose time debating how to dispose of his salary, since his wages were ten thalers a month.

He retained the position for five years. He was patience personified. He seemed to relish monotony. While preparing

JOHANNES MULLER

Painted in 1856 by Begas for King Fredrich Wilhelm IV, after Müller's sea-accident.

the skeleton of a giant ray he would sit for a week and continuously scrape its fins. But as one of his colleagues said, "Those were great times. Any day a bit of animal tissue, shaved off with a scalpel or picked to pieces with a pair of needles, might lead to important ground-breaking discoveries." Henle, the author of the above quotation, has left for posterity a verbal portrait of Schwann: "He was below the medium stature, with a beardless face, an almost infantile and always smiling expression, smooth, dark-brown hair, wearing a fur-trimmed dressing-gown, living in a poorly-lighted room on the second floor of a restaurant which was not even of the second-class. He would pass whole days there without going out, with a few rare books around him and numerous glass vessels, retorts, vials, and tubes, simple apparatus which he had made himself."

An assistant who is willing to keep himself in the background is appreciated by the Faculty, and as the professors were preparing an *Encyclopedic Dictionary of the Medical Sciences,* the intelligent but unobtrusive Schwann was asked to contribute some articles.

But at this period an event of extraordinary importance was transpiring at Berlin. Johannes Müller was engaged in preparing his *Handbuch*—the physiological world was being placed between covers—and among those who were selected to assist in the experimental work required, for nothing went into Müller's book until tested by himself or associates, was Theodor Schwann.

Dr. Schwann now learnt the joy of research: that peculiar excitement a man feels when he knows something that is not in any text-book. Schwann was in his twenties, but was far more interested in frogs, fibers and sheaths, than in wine, woman and song. He was busy proving the restorableness of cut nerves, inventing the muscular balance, discovering the sheath that bears his name, examining the textures of voluntary muscles, pointing out methods of isolating primary fibers, demonstrating the origin of the transverse striæ of their primitive bundles, showing the muscular contractility of arteries, convincing himself that yeast was an organic growth, experimenting in digestion which later led to his discovery of pepsin.

When the great *Handbuch der Physiologie des Menschen* finally appeared, Schwann was gratified to find several references to himself: "In the crural vein of the ox, Schwann found. . . . I have frequently observed this phenomenon as Schwann has described it. . . . Lastly, Schwann has recently ascertained by means of the microscope. . . . Schwann has proposed another explanation. . . . It has been shown by Schwann to consist. . . . This notion is disproved by the fact that Schwann. . . . Some very accurate experiments instituted by Schwann. . . . According to the observation of Schwann. . . . Schwann inclines to the opinion. . . . My assistant, Dr. Schwann. . . . Thus demonstrated by Schwann. . . . Most of what we know about this subject we owe to Schwann. . . . The recent important discoveries of Schwann. . . . The proportion of acid recommended by Schwann. . . . Now Schwann has shown. . . . It results from Schwann's investigation. . . . Schwann's discoveries are to be ranked among the most important steps by which the science of physiology has ever been advanced."

According to Schwann! A pleasing phrase which told him that he had achieved scientific fame: for was he not immortalized in a German text-book?

It was at this time that Schwann announced that infusoria do not originate by spontaneous generation. He was one of those who uprooted the belief in *generatio equivoca* till it fell like phlogiston and the vitalistic theory into those retired fields that are traversed only by the historical student of science.

The Greeks admitted that every primatic mammal had a father and a mother, but they thought the lower animals could arise *de novo*. Anaximander believed that the stimulating influence of moisture brought animals into existence, and Aristotle himself wrote that "sometimes animals are formed in putrefying soil, sometimes in plants, and sometimes in the fluids of other animals."

The Romans were no wiser, and in a striking passage of the *Georgics* Virgil describes the abiogenesis of bees, while the same thought is expressed in a couplet by Ovid:

> Hide in a hollow pit a slaughtered steer,
> Bees from his putrid bowels will appear.

Of course during the thousand years of insanity known as the Middle Ages such notions were universally accepted, and even Van Helmont published directions for the artificial production of mice. Such is the tenacity of error, that when Sir Thomas Browne said he doubted if mice could really come from a soiled shirt, or be bred by putrefaction, Alexander Ross angrily exclaimed, "To question this is to question reason, sense and experience. If he doubts of this let him go to Egypt, and there he will find the fields swarming with mice, begot of the mud of the Nylus, to the great calamity of the inhabitants."

The first man who shed light on the problem of equivocal generation was the seventeenth century physician-poet, Francesco Redi, who came to the conclusion that the maggots found in decaying meat were not produced spontaneously by the meat, but had been deposited there by flies. His proof consisted in covering meat with a fine gauze, through which the putrescent odor escaped: the flies buzzed around it, but as the meshes were too small to permit their eggs to fall through, no maggots were generated in the meat, but were hatched on the gauze.

A few years later a new door was opened in biology when the glorious Dutchman Leeuwenhoek looked through a microscope and discovered bacteria. Thereafter, as far as most scientists were concerned, the debate about the origin of life resolved itself down to this point: Can the lowest forms of life be produced abiogenetically? Even to-day can be found country-people who believe in showers of frogs, and that horse-hairs kept in water turn into eels.

A liquid was heated to the boiling-point to destroy all living organisms, and the tube was sealed to prevent contamination from the outside air. As a rule these solutions remained sterile, but sometimes microörganisms were found in them. "This proves," claimed the abiogenists, "the occurrence of spontaneous generation." "No," said the biogenists, "it proves only the imperfect sterilization of the fluid, or improper exclusion of germ-laden dust."

All along the line the victory had been in favor of the doctrine that living things are produced only from antecedent living things. But when oxygen was discovered, and it was shown that this gas is essential to all forms of life, the question was asked: Was not Spallanzani's failure to find life in his infusions due to the fact that he heated his tightly-closed flasks till the oxygen lost its vital property?

It therefore became necessary to test the problem from the oxygen standpoint. In 1836 and 1837 Franz Schulze and Theodor Schwann devised experiments by which the air of the atmosphere that entered the flasks was compelled to pass either through strong sulphuric acid or through highly heated tubes. The oxygen of the atmosphere was not injured, but the germs were, and no life appeared in the cultures. Again the result was wholly in favor of biogenesis.

In 1854 a further blow was given to the doctrine of spontaneous generation by the discovery of Schroeder and van Dusch that "if the mouth of the flask containing putrescible fluid was protected by a plug of cotton-wool through which an abundance of air could freely enter and exit, but by which it would be filtered, no life appeared in the contents."

In 1859, however, the entire question was again befogged and unsettled by Pouchet's emotional book. But then followed the classic experiments of Pasteur and Tyndall, and the theory of spontaneous generation was relegated to the ample museum of abandoned beliefs. This was one of Pasteur's greatest triumphs, and when the plaudits of the scientific world were ringing in his ears, he remembered that Schwann's experiments on fermentation had been of value to him and he sent the German a letter of gratitude.

But although Pasteur proved beyond the possibility of doubt that when the infusion is sufficiently boiled and the air chemically purified no organism makes its appearance, it must be emphasized—as it is often forgotten—that his demonstration has not in any manner affected the question of the origin of organic matter. Pasteur showed that under certain artificial conditions life is not produced, but does this shed any light on the genesis of the earliest organism?

We watch an amœba and we say that this is the simplest form of life, but how did the first amœba arise? We no longer believe in gaps and leaps; in the long chain of nature there is no missing link. It is less than a century since the first organic compound was prepared artificially on a laboratory-desk. Schwann's work on muscular force and du Bois-Reymond's and Helmholtz's elaborate experimentation with animal electricity further helped to demolish the vitalistic hypothesis, and we are continually adding planks that will eventually bridge the gulf between the organic and the inorganic. Daily the chasm that separates the living from the dead is growing narrower—we are filling it in with facts which tend to prove that organic matter evolved from inorganic.

When Butler Burke enclosed sterilized beef tea in a tube and allowed the emanations of radium salts to attack it, in a few hours, within the closed tube, specks appeared and grew and subdivided as if they were bacilli. Yet these specks were not living things; they were inorganic particles, but the radium had quickened the dead matter till it acted like the lowest organisms do. Perhaps it is time to change a few of our definitions.

Much as Darwinism has explained, it made no attempt to solve the problem of the first appearance of life on earth. But certainly we are not to assume a special creative act for the first organism: we must apply the doctrine of evolution here as everywhere. A complex organism developed from the cell, and the first cell developed from a substance simpler than a cell, the non-nucleated particles of plasm called the monera. And this first gelatinous mass, the simplest of all living matter—where did that come from? Ah, here is the essence of the question of the origin of life, but we shall not shirk it. We who are young, let us be as brave as the old Haeckel: the monera, as the lowest form of organic life, must have evolved from inorganic carbon-compounds, and thus in the broad sense we must believe in life which originated without antecedent life, and accept the hypothesis of spontaneous generation.

Yet we confess it is with an uncertain voice that we utter these words. The trouble is that we cannot write the chemical formula of a protein. The white of egg consists of carbon, hydrogen, nitrogen, oxygen and sulphur. If we could only take these five elements and mix them in our beakers or heat them in our crucibles or freeze them in our ammonia tanks till they albuminized, man would become the possessor of the secret of secrets. This is the crux of all biologic problems: to create a bit of protoplasm. A chemist can make butter: when the biologist learns to lay an egg he will have solved the problem of life.

One of the last topics which Müller discusses in his *Physiology* is Schwann's cellular theory. But here it is necessary to introduce another personage—Schwann's friend, Matthias Jacob Schleiden. Certainly there was nothing mutual in the temperaments of Schleiden and Schwann. Schwann was colorless and characterless, but Schleiden had personality plus. Schwann was a pigeon, Schleiden a storm-petrel. No provocation could lure Schwann into a controversy, while Schleiden counted that day lost in which he had not argued. Schwann was pious, while Schleiden openly proclaimed his disbelief in religion. Schwann was gentle and passive, a negative man; bold and fiery was Schleiden, a positive force.

On reaching the age of twenty, Schleiden saw it was time for him to do something, and he entered the university of Heidelberg to study jurisprudence. He graduated, and was willing to practice law, but although the courts were full of plaintiffs and defendants, and Hans did trespass *ab initio* on the property of Fritz, and A forgot the contract that he made with B, and there was litigation between grantor and grantee, and the appellants swore to sue the appellees, and man loved not his neighbor but loved his neighbor's wife, and busy attorneys spoke much of *prima facie* and of *ex debito justitiæ* and *damnum absque injuria*—yet no clients came with cash to Counselor Schleiden. The business did not pay, Schleiden struggled for a time, then grew discouraged, and as he did not possess the judicial mind—never having been elevated to the bench—he attempted suicide and was again unsuccessful.

Schleiden then told his father that he had decided to study science, and his father, who was a physicist, encouraged him. So at the age of twenty-seven Schleiden arrived at Göttingen to begin a new career. This was in 1831, a few years before the famous seven professors were expelled, and the university was in a healthy condition. From Göttingen Schleiden came to Berlin where he plunged into botanical studies with all the ardor of his passionate nature. "With his interest in botany," says Wilhelm Bölsche, "a new life began, and he worked with the energy of one raised from the dead."

One day Schleiden and Schwann were dining together, discussing their researches. "I have come to the conclusion," remarked Schleiden, "that the nucleus plays the chief part in the development of vegetable cells."

Someone entered the restaurant, and the friends looked up for a moment. Not far from them three young men were standing in front of mugs filled brimful with beer. At a given signal they raised the steins from the table, and drank with astonishing speed; the youngest finished first, brought his empty jug back on the table with a triumphant bang, and received the congratulations due to a champion.

"Manifestly," resumed Schleiden, "the discovery of the nucleus was a great piece of work—it will yield tremendous results. To the health of Robert Brown! Really, I think I can trace back every plant embryo to a single nucleated cell."

"What you say," said Schwann, "reminds me that I have seen a similar organ in the cells of the dorsal cord upon which Professor Müller has put me to work. Besides, in the vertebrate notochord Müller has pointed out the existence of cells resembling those of the plant."

"Let me see these cells," said Schleiden. They hastened to the laboratory, and looking through the microscope the eager eye of Schleiden saw that the nuclei of the chorda dorsalis were similar to the nuclei of vegetable tissue. "Identical," exclaimed Schleiden.

"Then," mused Schwann, "it must follow in consequence of this identity that your conception must be extended also to the animal world. This means that the cell is the unit of all organic structure."

In this manner did modern biology begin. What the molecule is to the chemist, the cell is to the biologist. Schleiden, the real father of the cell doctrine, wrote a short paper on the subject—*Ueber Phytogenesis*—sent it to Müller's *Archiv,* and then wandered off into other fields.

Schwann, with his characteristic patience, sat down and began to test nails, feathers, enamels, and all organic tissues he could think of, found them all to be of cellular origin, and then wrote his elaborate treatise, *Microscopical Researches into the Accordance in the Structure and Growth of Plants and Animals.* It was a work that "set the crown of immortality upon an unwrinkled forehead." Here for the first time we find the now familiar term, cell theory: "The development of the proposition that there exists one general principle for the formation of all organic productions, and that this principle is the formation of cells, as well as the conclusions which may be drawn from this proposition, may be comprised under the term cell theory."

There had been vague foreshadowings of this theory in

Berlin Octob. 20th 1834

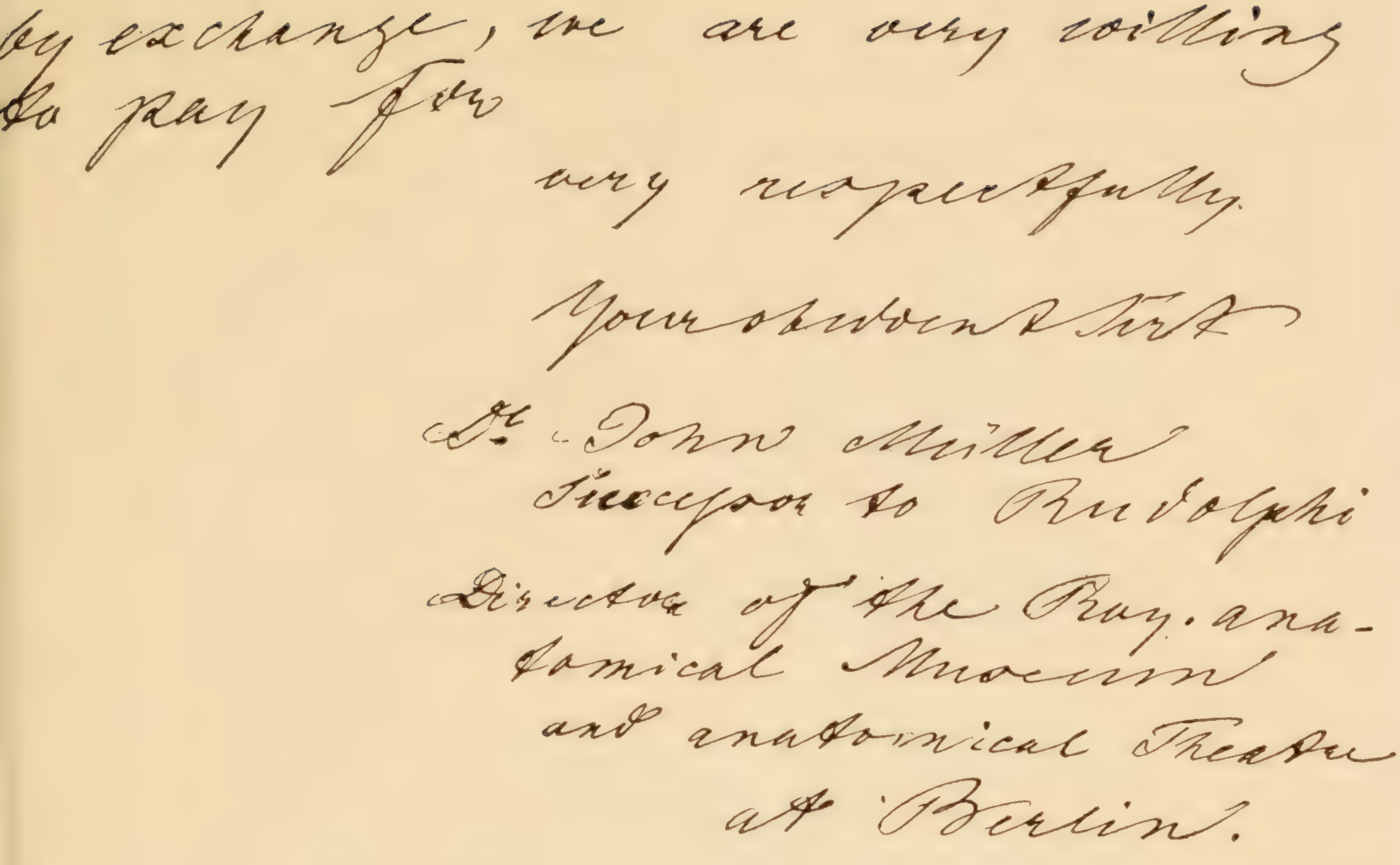
Dear Sir!

The Royal Museum, over which I preside, is anxious of connecting itself with You for the purpose of scientific intercourse and the exchange of natural curiosities. — We have a great collection of skeletons and a great many preparations preserved in Spirits of Wine, among which are many Doublets. — I send You herewith a list of our Skeletons which we have double, and offer myself to send You likewise a list of those in spirits of wine. In return I request You, to name us those which You could let us have. — We feel particularly interested in all rare american animals, as many are wanted in our collection, as for instance of South american: Chlamyphorus, Chinchilla, Testudo matamata, Bradypus didactylus, torquatus, Manati and many more. Of North Americans: Ondatra, Bison, the different species of Siren, Bos moschatus, Condylura, Scolops, Menobranchus lacepedii, (the M. lateralis we have) North american accipenser, Polyodon folium, Testudo Pyxis Kinixys, serpentina, ferox &c. —

If you are willing to send us some of the above named, I request you to do this through the Prussian Consulate and to address them to the Royal anatomical museum at Berlin. —

At the same time you will please to name us those, you wish us to send to you. — I offer myself likewise to send you all those German works on Natural history, which you should like to possess —

P.S. Any thing we cannot get



by exchange, we are very willing
to pay for

very respectfully

Your obedient Servt

Dr. John Müller
Successor to Rudolphi
Director of the Roy. anatomical Museum
and anatomical Theatre
at Berlin.

LETTER BY JOHANNES MÜLLER WRITTEN IN ENGLISH

former centuries—everything intellectual germinated in the infinite brain of Aristotle. From the Greek we must skip to the Englishmen Hooke and Grew who drew cells, and to Malpighi and Leeuwenhoek who sketched the microscopic structure of plants—though neither of these naturalists had any idea of the importance or the universality of the cell. Kaspar Wolff came much nearer to the truth, while Lorenz Oken was hot on the trail when he wrote that "animals and plants are throughout nothing else than manifoldly divided or repeated vesicles, as I shall prove anatomically at the proper time," but the proper time never came for him, for the brilliant transcendentalist, though the most lucky of guessers and a dreamer of the highest rank, seldom cared to furnish proof for his statements.

In truth Schleiden and Schwann received scant aid from their forerunners, and subsequent investigators have had occasion to modify considerable of the founders' work. For instance, Schleiden thought he had seen cells arise *de novo,* and not only by the division of preëxisting cells, and strangely enough, Schwann who had done effective work against spontaneous generation, followed him in his misconception. It remained for Virchow to announce *omnis cellula e cellula.*

Some of Schleiden's and Schwann's mistakes were inherited from the seventeenth century. Thus, in 1665, Robert Hooke, whom we have mentioned before, cut a thin section of cork with his penknife, looked at it through his microscope, and described what he saw as made up of "little boxes or cells distinguished from each other," for in cork the cell-wall is the most prominent element. After the publication of his *Micrographia,* showing the earliest known pictures of cells, it was believed that the cell wall was more important than the cell contents. We now know that the cell wall or limiting membrane, though conspicuous in vegetable tissue, is non-essential, and is present in but few animal cells.

It is true that within the cell wall Schleiden had seen a substance which he simply called gum and forgot. But a host of workers—Dujardin, Purkinje, von Mohl, Nageli, Ferdinand Cohn, DeBary, Virchow—kept their eyes screwed on Schleiden's gum till they pronounced it the essential substance of all living cells. Then came one whose vision saw the correlation of this vast biologic leaven, and Max Schultze joined the cell doctrine and the protoplasm doctrine into one harmonious whole, and each fact fell into its place like the elments in Mendeleyeff's Periodic System. A few years later, on a Sabbath evening, Huxley proclaimed to a popular audience that life has a physical basis, and then proceeded to lecture on protoplasm.

So we see how far others advanced beyond Schleiden and Schwann, but the glory of pioneer work is theirs.

The time must have been ripe for the cell-theory, for instead of the calumny which is the usual lot of the innovator, both Schleiden and Schwann reaped rewards.

The great Catholic University of Louvain—which had been swept away by the French Revolution, and had just been reestablished—needed a professor of anatomy, and Theodor Schwann, twenty-nine years of age, was asked to fill the chair.

Jena likewise needed another member on its teaching staff, an adjunct professor of botany, and the position—it is believed on Humboldt's recommendation—was offered to Matthias Jacob Schleiden.

For ten years Schwann taught at Louvain, and for more than thrice ten he was professor at Liége. Breslau asked for him in 1852, Würzburg and Munich wanted him in 1854, and the following year he was invited by Giessen. But his Fatherland never got him back. For the rest of his days Schwann lectured in a strange tongue. The Catholic atmosphere of Belgium suited him better than the rationalistic spirit which was invading the German universities. He came to Germany only during the Christmas vacations to visit his parents and brothers and sisters in the neighborhood of Cologne.

Schwann arrived in Belgium, young and famous. Over forty years of work yet remained to him. These forty years were the Golden Age of Science in which the entire scientific world was recast—vastly improved. A thousand hypotheses were overthrown, musty theories were hauled into the light of day and re-examined, discovery crowded thick upon discovery, the world was flooded with fact, and Truth rose glorious as never before. Biology entered every home,—and environment, adaptation, atavism, hereditary transmission, struggle for existence, and survival of the fittest, ceased to be technical terms and became colloquialisms.

What did Schwann accomplish during all these fruitful years? Well, he published a monograph on bile, but nothing else. He went to an honored grave in his seventies, but over his coffin waved the laurels he had earned in his twenties. Age added not a single leaf to the crown of immortality which he won in his youth. Schwann was not an original thinker; he could work only when he received the stimulus from a strong man like Müller or Schleiden. It is a pity that he feared the atheism of the German students. Had he accepted the call to Würzburg, for instance, Schwann could not have witnessed von Kölliker making a new discovery in histology every year without being inspired to emulate him. However, there is nothing peculiar about Schwann's case: many a young man has done brilliant work while occupying an obscure post; then they make him a Hofrat or a Geheimrat, and he does nothing —except discover that it is easier to repeat last year's lectures than prepare new ones.

But peace is the great narcotic that is apt to lure us all into a life of nothingness. And yet Schwann's long uneventful existence in Belgium was disturbed at least once:

Louise Lateau, the pious daughter of a Belgian miner, was so very ill that she received the last sacrament. But she did not die; she fell into an ecstasy—from which only Bishop Dumont of Tournay could awaken her—and her body became marked with the print of her Savior's bruises. Often for hours she had contemplated the crucifixion, and now on her own body appeared the injuries that had been inflicted upon

Christ. Where the crown of thorns had been set, where the nails had been hammered, and where the Roman soldier had thrust in a spear, Louise Lateau was sorely wounded. This case of stigmatization excited considerable interest, a committee was appointed to investigate whether her wounds were due to natural or supernatural causes, and Theodor Schwann was asked to be a member.

To one not connected with the Catholic Church the case had no special significance and offered no insuperable difficulties. All that was necessary was to observe the girl, question her, study her condition, and write a report. But stigmatization is one of the accepted miracles of Catholicism, and for a son of the Mother Church to disbelieve in it was like denying the efficacy of transubstantiation or the possibility of the resurrection. It was all very well for some German materialist to say that stigmatic neuropathy was a pathological condition of occasional occurrence, explainable by physical and mental conditions. It was easy enough for others to point out the analogy between vicarious menstruation and hemorrhagic exudation, and to talk about hystero-epileptic conditions and the effects of automatic attention upon the body; it was natural for a scoffer to say that many cases of stigmatization had been found to be fraudulent, and that Theresa Städele, Rosa Tamisier, Angela Hupe, Sabina Schäfer and others had been imprisoned for their impositions; and who could help it if an infidel claimed that the crown of thorns on Rita of Cascia's forehead was simply a circle of pimples due to smallpox? It was not difficult for the cynical Dr. H. Boëns to spy upon this Louise Lateau and to announce that she frequently rubs and scratches with her nails and with a rough cloth, especially during the night, the places where the blood flows, and that she keeps up on these spots, even mechanically during sleep, pressure with her fingers, so as to maintain a condition of local congestion —he was no better than Professor Bodde who had examined Anna Emmerich's wound-prints, and pronounced the blood-marks due to sanguis draconis. But had not popes anathematized those who failed to believe that stigmatization was an evidence of God's favor towards his saints?

The Church indicated nearly a hundred instances in which miraculous stigmatization had occurred. This divine chastisement was first inflicted in 1224 upon St. Francis of Assisi, who had retired to a hermit's hut at Mt. Alverna in the Apennines. In a vision the saint saw a seraph whose face burned with fire and radiated light in every direction, and between whose wings appeared an image of the Crucified One. When Francis awoke he was stigmatized in imitation of Christ, and St. Clara could not pull out the nails.

Because of this event the Franciscans soon overshadowed the older order of St. Dominic, but in the next century God saved the reputation of the Dominicans, for a bloody sweat bathed St. Catherine of Siena, the Dominican sister, then the coronation with thorns appeared, and finally the lance-wounds.

Since that time stigmatization occurred more frequently—God having become accustomed to the work—and the Church pointed to St. Leo whose body at birth was marked all over with red crosses due to the intense meditation of his mother on the passion of Christ, and a sign that the child himself would carry the cross to his life's end. There was Maria von Morl whose stigmata in the hands, feet and side were witnessed by over 40,000 persons. St. Gertrude of Ostend during Holy Week felt five punctures, two in the hands, two in the feet, and one in the side; from these stigmata blood flowed seven times a day at the seven canonical hours, but when the crowds came to see the miracle, Gertrude feared she might grow vain, and prayed that the flux of blood might cease, and although her desire was granted, the marks of the Passion remained till death. St. Catherine of Ricci was known as the virgin bride of Christ, for the Savior himself placed upon her finger an engagement ring, and marked her body with the sacred stigmata, since which time, during Passion week, she experienced all the torments of the Redeemer. A similar case was that of St. Lidwina: angels came to her, and not only did she converse with them, but even called them by name; she was also granted personal interviews with her celestial spouse, who on one occasion impressed on her body the marks of his suffering, but to avoid vanity she entreated him to render these stigmata invisible to others, a favor which was accorded to her.

And these cases, which we have reported in almost the words used by the ecclesiastics, were but a few out of many. How then could a true Catholic like Schwann deny them? Had not the Bulls of Pope Gregory IX expressly commanded his subjects to accept them as a proof of divine intervention in human affairs? Schwann's decision was a foregone conclusion, and hasty clerical papers, without consulting him, announced that he regarded Louise Lateau's wounds as miraculous.

But the statement was premature. All his days Schwann had dwelt in the shadow of the house of truth. While yet a child he had consecrated his life to her service; his prayer had been heard, and Science laid her hand upon him. In her name he had been admitted to holy places: clothed in her garments he had clasped the hand of Johannes Müller, and for five years he dwelt in the master's temple.

It was time for him to draw up his report; before him lay the blank paper. Out of the ink-horn rose the ghost of Loyola and beckoned to him: "You are one of us—deny us not!" Now Schwann knew there was no miracle connected with the wounds of Louise Lateau. Schwann wrote, but over his pages fell the spirit of science. The man was true to his youthful vow.

Upon the publication of Schwann's report the clerical press was equally astonished and enraged, and a bucketful of printer's ink was poured upon the amiable old man. Harsh epithets were coined in editorial offices, but Theodor Schwann made no reply. For a lesser offense the aged Galileo had been forced to recant on his knees, and men had been marched to the stake, but the nineteenth century was better than the sixteenth: it was the Age of Biology, and in a Catholic institution

Schwann retained his professorship. Great Galileo was right in more ways than one: *Eppur si muove!*

In the meanwhile we have left Professor Schleiden at Jena—the most liberal school in Germany. It is true it couldn't tolerate the metaphysical atheism of the moral Fichte, but this was before Wolfgang von Goethe had time to make the little university eager for new ideas. When Schleiden began to teach botany, the science was overrun by obsolete Linnæan survivors who thought the only occupation of the naturalist was to clip, collect and catalogue.

In the midst of their pedantic rules, jauntily upsetting their archaic laws, Schleiden flung his *Principles of Scientific Botany,* in which, for the first time, botany was treated according to the inductive method. The work was dedicated to Humboldt, no doubt as a personal tribute, but also to indicate that the author considered botany related to the other sciences. The preface begins gently thus: "Whoever thinks he can learn botany in this book may as well put it aside at once without reading it, for botany cannot be learned from books." Those of us who studied phyllotaxy in Asa Gray's Botanical Text-Book, and recall with a shudder its hopelessly monotonous pages, may well regret that Schleiden's book has gone out of use. We admit it sometimes digressed and sometimes indulged in personalities, but that only made the calyx and the corolla more interesting. Schleiden was certainly the most tempestuous plant that grew in the botanical garden.

The foremost historian of botany has reviewed *The Principles of Scientific Botany* in words too significant to be omitted: "Schleiden's book," writes Julius von Sachs, "was the first of its kind that supplied the student with really good figures based on careful observations. With all its many and obvious defects it had one merit which cannot be rated too highly; its appearance at once put botany on the footing of a natural science in the modern sense of the word, and placed it upon a higher platform, extending its horizon by raising its point of view. The difference between this and all other previous text-books is the difference between day and night; in the one an indolent carelessness and an absence of ideas; in the other, a fullness of life and thought, calculated to influence young minds all the more, because it was in many respects incomplete and still in a state of fermentation. On every page of this remarkable work, by the side of facts really worth knowing, the student found interesting reflections, a lively and generally coarse polemic, and praise and blame of others. It was not a book to be studied quietly and comfortably, but one that excited the reader everywhere to take a side for or against, and to seek for further instruction."

Schleiden followed this work by another equally successful —*The Plant and its Life.* Its object was to popularize botany and to show that the botanist is no longer merely a dealer in barbarous Latin names, a man who gathers flowers, names them, dries them, and wraps them up in paper, and all of whose wisdom consists in determining and classifying the hay which he has collected with great pains.

This volume might well be called the poetry of botany. It is a lyric of leaves, an epic of oaken esplanades. As we turn its pages we hear the sap stir in the young trees, and the old branches on the ground crackle under our feet; we inhale the sweet jessamine, and the willow shakes its pollen in our faces.

Only a poet could have written this book and Schleiden was a poet: he even wrote verses under a pseudonym. Contrary to a general belief, many scientists possess an artistic streak. Tyndall was the troubadour of the Alps; Ludwig Buchner, the arch-materialist, wrote poetry that deserves to live; if Dujardin's miniatures had sold, he would never have concerned himself with sarcode; by the side of Max Schultze's microscope lay his violin; August Weismann too, when he could no longer gaze down the ocular, solaced himself with music; Auenbrugger wrote an opera, and Claude Bernard a drama; and the investigator of the Radiolaria confessed, "In Sicily I was nearly thrown out of my line and made a landscape-painter." It is true there are many plodders in the universities

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and laboratories who scorn what they call imagination, and pride themselves on being exact scientists; these are the sort who modify someone's reagent, or succeed in improving a separatory funnel for quantitative extraction, but they seldom do big work. We might mention Cavendish as a conspicuous exception, but who can gauge that chemist's mental processes?

The Plant and its Life appeared in England, translated by the botanist Arthur Henfrey. In 1853 the work was published in the United States, but not in its entirety, as some of Schleiden's heresies were considered too shocking to meet the innocent eyes of the God-fearing Americans. The editor of the edition, Alphonso Wood, calmly announced, "We have taken the liberty to suppress passages, which were liable to be construed as irreverent." It has long been known that few masterpieces of European literature appear in America in their full virility, but it may be news to some that even scientific writings are emasculated before being served to our dainty mental palates. We wonder if the time will ever come when the prudes and the hypocrites will be prevented from tampering with the works of better men.

The charm of this volume made many converts for botany. It is related of one bright German lad that three books especially influenced his formative years—excluding the works of Goethe. They were Humboldt's *Aspects of Nature,* Darwin's *Naturalist's Voyage Round the World,* and Schleiden's *The Plant and its Life.* While still a school-boy at Merseburg the ardent reader dreamed of studying botany under Schleiden at Jena. Indeed, having an indulgent father, he was permitted to visit the land of his desire. In vivid words he has himself told how after reverently admiring the Goethe-room in the castle of Dornburg, he wandered, on a hot July day, over the shady meadows to Jena, singing lustily with his gay comrades. As he entered the venerable old market-place he found a troop of lively students in front of the Burgkeller, with colored caps and long pipes, singing, and drinking the famous Litchtenhain beer from wooden tankards. It made a great impression on him and as he took a tankard with them he made up his mind that he would some day be one of them.

Two years later the examinations were passed and he engaged rooms at Jena. But before the term began he determined to find a specimen of *Scilla bifolia* and show it to Schleiden. The day was cold, the meadows were wet, the plant was rare, and the collector was imprudent. Hours passed before he discovered the squill, but he satisfied the collector's mania, and he was happy. That night he was attacked by a chill, he felt nauseated, there was a painful stiffness in his joints—it was a beautiful case of rheumatism. The student had to return to his parents at Berlin, and Schleiden began his classes without Ernst Haeckel.

While pursuing his botanical studies Schleiden often had occasion to delve into the historical portion of his subject, and was surprised at the prominent rôle which the Jews played in the growth of science; going deeper into the matter his surprise turned into admiration and he expressed the results of his researches in a booklet on *Science among the Jews before and during the Middle Ages,* which was followed by his *Romance of Jewish Martyrology.*

In the first-named production he lambastes the Christians with downright vigor and extols the Hebrews as paragons of virtue and wisdom. He declaims against the barrenness of monastic medicine and eulogizes the superior attainments of the countrymen of Maimonides, though the passion displayed may cause some to imagine that he carried the odor of the law-court into the halls of science. "All Europe," writes Schleiden, "had its Middle Ages, a period of barbarism, of intellectual and moral decay, as deplorable as any that can be conceived. Only the Jews formed an exception. Despite dispersion and oppression, which often robbed them of the very right to live, they continued to develop their intellectual life, without interruption, to the end of the Middle Ages, preserving and transmitting to other nations the bases of morality and of mental life. Like all nobly endowed natures, they stumbled now and then during happy moments, when the burden of existence was lightened, but every reverse of fortune, every affliction, however bitter and severe, only serve to ennoble them, to quicken them to higher mental and moral effort."

We quote this paragraph because it is interesting, but probably too much has been written about the achievements of the Jewish physicians of the Middle Ages. If they shine, it is because of the surrounding darkness of monastic medicine. Impartially speaking, what discoveries of fundamental importance did they make in science? They spoke words of wisdom, such as "the disagreement of two physicians is more dangerous than a tertian fever," but the Semitic races, alas! gave man his theology—Judaism, Christianity, Islamism—and not his science. The great Jewish investigators date from the mid-nineteenth century and not from mediævalism, and they derive from Hippocrates and not from Maimonides. Not Jerusalem, not Mecca, but Hellas is our holy land.

Schleiden's name will ever remain illustrious as a reformer of botany, but versatile men are apt to be impatient, and Schleiden had a habit of reaching conclusions on insufficient evidence. His opponents were not slow in pointing out the misstatements of this opinionated botanist. At first Schleiden fought with both fists in defense of his assertions, but more than once he was defeated by proof. Schleiden was impressionable: he became disgusted with himself and lost interest in botany. When the third edition of the *Principles of Scientific Botany* appeared, it contained no revisions by the author—Schleiden would not bother with it. Quite different was the careful histologist Kölliker who enlarged his *Handbuch der Gewebelehre* after he had passed the age of seventy-five. Later *The Journal of Scientific Botany* ceased publication, for Schleiden refused to edit it any longer. Finally, in 1862, Schleiden reigned his professorship.

He went to Dresden, and dallied with anthropology. But Schleiden had a reputation, and Dorpat made this offer: the chair of botany and anthropology, with the rank of a Russian councilor of state. Schleiden accepted, and thus the Livonian university acquired another attraction besides Fraunhofer's refracting telescope. But Schleiden interspersed his lectures with sundry uncomplimentary remarks regarding the dominant theology, and soon he was invited to allow the great telescope to shine alone in its glory.

He returned to Dresden—the German Florence, as Herder called it—and immersed himself in philosophy; from Saxony's capital he came to Frankfort, and must have been reminded of his former panegyrics when he passed the famous Ghetto—the same *Judengasse* where the beautiful young Goethe had lingered with curiosity and received the smiles of Jewish maidens. For a time he was at fashionable Wiesbaden, but returned to Frankfort-on-the-Main where his last days were spent. During the summer of 1881, at the age of seventy-seven, the unique Schleiden passed away. During the Christmas season of the following year, while visiting his relatives, Schwann received the fatal stroke which carried him off, aged seventy-two.

Three-quarters of a century have passed since the inauguration of the cell-theory, and the names of Schleiden and Schwann have grown historic.

In that incompleted but immortal introduction which was still in the making when its author perished of a fever at Damascus, crying, "My book, my book, will never be finished!"—we find a foot-note to this effect: "There is, however, now reason to think, that both animal and vegetable tissues are, in all their varieties, referable to a cellular origin. This great view, which M. Schwann has principally worked out, will, if fully established, be the largest generalization we possess respecting the organic world, and it would be difficult to over-rate its value."

Buckle's prophecy has been fulfilled: to-day we cannot deal with heredity, reproduction, embryonic development, repair, regeneration, anabolism, katabolism, motion, locomotion, or questions of stimuli, without going back to the cell.

"I believe without hesitation," said Oskar Hertwig, addressing the Congress of Scientists at Aachen in 1900, "that I must indicate as one of the greatest acquisitions of biology during the nineteenth century the discovery that plants and animals are built up of cells, of innumerable elementary organisms."

In the *Allgemeine Physiologie* of Max Verworn of Jena, are written these words: "It is to the cell that the study of every bodily function sooner or later drives us. In the muscle cell lies the problem of muscular contraction and of the heart beat; in the gland cell reside the causes of secretion; in the epithelial cell, in the white blood corpuscle, lies the problem of the absorption of food, and the secrets of the mind are hidden in the ganglion cell."

Had it not been for the cell-theory Darwinism might have gone begging in its day, but when men saw that all living things, from a blade of grass up to an Asiastic elephant, arose from a cell and consisted of cells, it was easier to believe that such universal resemblances were due to a common descent.

At least a dozen different men have been hailed as the father of modern biology, and as it is a wise science that knows its own father, we will not examine the parentage too closely. Yet, in view of the fact that to-day our text-books in histology, embryology, physiology, pathology, and physiological chemistry open with a study of the cell, would we be far wrong if we claimed the honored title for Schleiden and for Schwann?

(1809–1885)

JACOB HENLE

TO EMILIE RECHT:

If ever I had an inspiration, it was on the day when I first spoke to you about Jacob Henle. I explained that although he was one of the greatest medical scientists of modern times, practically nothing about his career had appeared in the English language. Not being a medical woman, you had never heard of Henle, and were naturally and properly bored. But since it is impossible for you to be unsympathetic, the subject was again broached, and somehow we decided to "do Henle"—as an experiment. Your share of the work was to consist in translating all the available German data, after which I was to use your translations as a basis for my own work.

The first article you undertook happened to be desultory and tedious, and after being engulfed in its discursiveness and battling with its technicalities, you would have abandoned your self-appointed task, but for two reasons: in the first place, you were probably curious to see what I could accomplish with such unpromising material; and in the second place, you are no shirker. So the work went on, and you translated the notices by Leyden, Flemming, and Pagel, the essay by Waldeyer, and Kussmaul's witty chapter in his Memoirs from the Youth of an Old Physician. By this time, the greatness of the man had grown upon us, and the experimental stage was over.

In the foregoing sketches, there were several references to Merkel's comprehensive life of Henle, and it may appear strange that we had not yet come across this work, but the reason is simple: in no book-store or library in New York could this volume be obtained, and it became necessary to apply to the Surgeon-General's Office for this authoritative biography of one of medicine's noblest figures.

When you opened Merkel, Henle was resurrected. The real enthusiasm for Henle now began, and it added a new thrill to our lives. In those days, no friend spoke to us without first inquiring about Henle. With what devotion you entered into the work, and how vividly your comments and exclamations brought the man before me! When some characteristic trait or incident stirred you to speak about Henle, I entered his home, observed him in all moods, wondered at his versatility, watched the humorous corners of his mouth, saw the movements of his eyes, and learned to know his very mannerisms.

In the following pages I have followed portions of your version more freely than I would feel warranted in doing if Merkel had appeared in English. For some unaccountable reason, however, this splendid biography has remained untranslated, and the English-speaking profession is indebted to you for making accessible to them many of the letters of Jacob Henle. The field of medico-historical investigation is my chosen work; there is rich reaping, and I do not know what abundant harvests I may yet find, but I never ask for a better yield than was gathered in the days when you and I did Henle. It was an unforgettable privilege to be associated with you in this work, and in dedicating this book to you, I feel that I am only returning what already belongs to you, for over every page of Merkel you cast the glamour of your own rare spirit.

XIX

JACOB HENLE

I. BOYHOOD DAYS

Let us begin this chapter with a simple declarative sentence: The book of Genesis and the writings of Lester Ward do not always agree.

According to the ancient author, man was created first and foremost, and later woman was fashioned to help the man—but the modern writer says:

> The female is not only the primary and original sex but continues throughout as the main trunk, while to it a male element is afterward added. The male is therefore, as it were, a mere afterthought of nature. Moreover, the male sex was at first and for a long period, and still throughout many of the lower orders of beings, devoted exclusively to the function for which it was created, viz., that of fertilization. Among millions of humble creatures the male is simply and solely a fertilizer.

But even among the highest creatures, nature needs the male for only a moment. When a child is born, its father may be in another country, or in the arms of a strange woman, or preoccupied, or dead. In the summer of 1809, when the Baiersdorf rabbi's daughter, Helene, gave birth to her son Jacob, no father stood at the bedside. Months passed, and still the growing infant did not learn that a father is a part of life's scheme. In the long evenings, the mother developed into an introspectionist, living her romance over and over, vividly recalling the most trifling incidents.

She was a member of a large family with a slender purse—

which means that she early became a student of domestic science. Her proficiency in this branch evidently became known, for Helene was invited by her aunt, Frau Henle of Fürth, to come to that flourishing little town and help to manage her household, which consisted of a husband and seven sons. If it be admitted that such a household requires expert management, it must further be acknowledged that a sprightly girl, in the midst of seven male cousins, is not apt to be neglected. The cousins appear to have wooed Helene *en masse*—the elder ones with the ease which comes from experience, and the lad Wilhelm with the bashfulness of a first love. "Faint heart never won fair lady," has been dinned into our ears until it has become a platitude; indeed, certain sociologists gravely maintain that even the most civilized woman has a secret craving for the cave-man who comes a-wooing with a club—but this is simply a picturesque theory, of value to writers of fiction. As a matter of fact, it often happens that the masterful courtship of practiced veterans cannot compete with the awkward devotion and mute adoration of a shy lover. Women appreciate modesty in their wooers, but no man is modest after his first conquest.

When Helene and Wilhelm were betrothed, she was twenty-one, and he was eighteen—hardly five feet high, with no money, and his school-books still on his desk. The uncertain future darkened unexpectedly, for the boy's father died suddenly, and through the legerdemain of unfaithful administration the family estate vanished. So Wilhelm Henle put away his unfinished text-books, and went out into the world.

In those days the shadow of Napoleon lay over Europe, and militarism was everywhere. Wilhelm, like many others, began his career by obtaining employment in the supply-department of the army. He had not the Midas-touch of a Rothschild, and no carrier-pigeons brought him fortunes from the air. But he hummed and whistled at his task, for the goal was clear before him. Wilhelm worked, while Helene waited—and after six years they were married in Leipzig. Then the young husband hurried off to business, absenting himself for considerable periods, leaving his wife alone to enjoy the countless literary and musical associations of Germany's cosmopolis. But neither the high-pitched vault where John Sebastian Bach had played the organ, nor the house where Klopstock wrote passionate odes to his disdainful cousin Fanny, nor the *Hof,* unforgettably portrayed in Goethe's Faust, could save the bride from loneliness and homesickness. Amidst the distractions of myriad-minded Leipzig, she wept for her little room in Fürth.

She prevailed upon her husband to bring her back to the parental home, so that Jacob was born in Fürth instead of Leipzig—thus losing his opportunity to be Richard Wagner's town-brother. The event occurred during one of the merchant's business-trips, and he did not meet his offspring until nine months later. A mother loves her child at first sight, but a father must become acclimatized. When Wilhelm first looked at Jacob, he saw before him a dressed-up child instead of a naked fetus smeared with vernix caseosa, and yet he could not escape the initial shock which comes to so many fathers. He frankly pronounced the youngster ugly—to the mother's amazement and dismay. But on closer inspection the critical sire modified his opinion to the extent of declaring the little fellow passable, and before again departing for business he had made the discovery that the sunshine lay in his baby's smile, and that his eyes were big and brown and beautiful.

Other children followed, and Jacob accepted it as a matter of course when he found himself surrounded by four sisters—Marie, Rosalie, Johanne, and Helene. They developed under the direction of their mother, as the traveling father was not sufficiently familiar with the family to be its task-master. The father who is at home nearly all the time naturally assumes the rôle of disciplinarian, but the father who visits his hearth at rare intervals is usually as indulgent as a grandmother. It is among the traditions of the Henle family that Frau Helene was capable of serious procedure, yet seldom was compelled to resort to chastisement, as all the children, although lively, were gentle and easily managed, having inherited their father's gracious nature. The most vivid recollection the Henle children retained of their father was his constant humming and whistling, for this merchant was a musical enthusiast. He was not a performer himself, but there were few operas or concerts which he missed, and after the first bars of any selection, he could finish the melody. Herr Henle cultivated business because it is necessary to live, but he didn't live until the opening notes of the overture.

While Jacob Henle was growing up, Johann Peter Frank was growing old. The founder of modern public hygiene had reached eminence, but the ascent was terrible: when Frank was less than a year old, his inhuman father, enraged at his cries, threw him out of doors; the little outcast survived infancy, but at the age of four was almost murdered by some boys; at nine he was taken to Italy by the Piarists to be castrated because of his fine voice, but he escaped to write in indelible ink the name of Johann Peter Frank on the annals of German medicine. He climbed to the mountain-peaks of fame, but when he looked backward along the trail, the ghosts of his childhood memories arose, all tear-stained and blood-beclouded. How different was the childhood of Jacob Henle! Guided by loving and discerning parents, he imbibed only the good and beautiful, ripening in an atmosphere of peace and culture and music.

Moving day, although greatly dreaded by adults, is much relished by youngsters. Children are natural nomads, and delight in changing their habitats. During his sixth year, Jacob had the opportunity of informing his companions that he was going to move. Fürth had become too limited for the Henles, and they were bound for Mainz—the Rhine-city which gave the printing-press to mankind. In 1815, moving was not an art, and accompanied by a female servant, a private tutor, and their baggage, the Henles rolled along for many a weary day in a hackney-coach before they sighted the steeples of Mainz.

Comfortable days followed, for the star of economic prosperity shone over the Henles. They lived in a good house, employed a male servant, kept horse and carriage—that badge of respectability—discharged the private tutor and engaged better ones, among them being Monsieur Hugier, who is credited with laying the foundation of Jacob's excellent French. Jacob studied the violin under Kreuser and Marie took lessons on the piano, and soon brother and sister could play duets. It was found that Jacob inherited his father's musical memory, and could reproduce entire acts of even infrequently performed operas. His musical ability, however, could not overcome his boyish passion for noise, for among Jacob's earliest compositions is this appeal:

> Dear Mother,—I have heard that there will be a beautiful performance and thinking that you will perhaps attend, I beg you to take me along. Herr Majot tells me that there will be fighting and shooting, and you know this is my only joy. I hope that this is not a bold request; should you, however, not be in favor of it and should not consent, you may nevertheless count upon my sincere filial love.
>
> Your affectionate son,
> J. Henle.

The parents had long planned the family's conversion to the dominant religion, one of their motives in leaving their native town being its essential Jewishness, Fürth owing its prosperity to Jews who had fled from persecution in Nuremberg. In Mainz it was easier to undergo Christian transformation, since it is the seat of a bishop. Having decided to become Christians, it was next necessary to decide what brand of Christian to become, whether Papist or Protestant, and then select the denomination. The two elder children, Jacob and Marie, had to write out the reasons for their choice, and there was much solemnity in the household—but over the ceremony of changing one theology for another let us draw the charitable veil of silence. To discard the trammels of an outworn creed is splendid, and it is unfortunate when expediency requires the re-riveting of similar fetters. However, we will close this episode by simply remarking that in his twelfth year, Jacob Henle passed through an experience which seldom befalls a rabbi's grandson—he became a member of the evangelical faith.

Business dictates where men should go, and when Herr Henle's affairs drew him toward the French border, the family contemplated removal to Coblenz. In order to make the preliminary arrangements, the father preceded his flock, and the mother prepared to follow—under the protectorate of Jacob. The little man felt the importance of his office, and was keyed up with excitement over the prospect of the journey. He thought the day of departure would never come, but it finally arrived, and caused Jacob Henle to wonder at the perverseness and unreasonableness of life. He did not feel well; his leg was hot and it ached, but he tried to hide his condition, for he was afraid of having to remain at home, and he was resolved, boy-like, to enjoy himself at all hazards. The carriage rattled on, every moment intensifying the aching and the swelling. The mother, engrossed with her plans, failed to notice that her son was unnaturally subdued. At last Coblenz was reached, but Jacob did not jump down in eagerness. He could not walk, and it was necessary to carry him to bed, where he spent a night of suffering. So the day which was anticipated with joy, brought with it nothing but sorrow.

Dr. Settegast diagnosed the case as periostitis, and for weeks Jacob lay in Coblenz, while his mother kept traveling back and forth from Coblenz to Mainz, to divide her attention between her scattered brood. Professor Leydig, the foremost surgeon of Mainz, was summoned to Jacob's bedside, and eased the patient with an incision; another period of exile followed, and when Jacob was able to be conveyed to Mainz, Leydig removed the necrotic areas with favorable results, although recurring attacks of periostitis plagued Henle at spasmodic intervals throughout his career. During his protracted convalescence, Jacob demonstrated Leydig's operation to his astonished sisters—with the aid of his father's strop and a button-hook. Unfortunately, the invalid's recollection of the operation was vivid enough, for 1821 was in the pre-chloroformic days.

Jacob's illness upset the family plans for a time, and it was not until 1824 that the Henles settled at Coblenz. Jacob was now fifteen, alive to everything, but interested chiefly in music and drawing. As he looked out of his new home, he saw a plain-looking house opposite. There was no gold within for thieves to steal, yet its unpretending walls held priceless treasures. Many youths—and certain elders—passed that humble door-step with desire, and accounted it a privilege to be permitted entrance. That rickety stairway led the pilgrim to a shrine, for here dwelt Herr Zeiller and his five charming daughters.

The blend of male and female voices was often heard in that home, mingling with the voices of the violin and piano, for the lives of the Zeillers were consecrated by music. Naturally the Henles drifted in, and the two families were mutually delighted with each other, passing many wonderful hours in song and play.

Among those who visited the Zeillers was a cobbler's son who neither sang nor played; sometimes his eyes flashed, but he seldom spoke or smiled; yet he came whenever he could, and watched Nanni Zeiller. Johannes Müller looking at Nanni Zeiller—science worshipping beauty.

Nanni's younger sister, the fascinating Malchen, had many admirers; she and Jacob formed the habit of singing together, and the world will not be surprised to hear that the young man's passion for music was complicated by a passion for Malchen. One of the symptoms of love is the desire to bestow gifts upon the object of adoration, but a boy's purse and his impulses are usually at variance, and Jacob was reduced to the necessity of stealing his mother's blossoming plant—which he presented to Malchen with the cautious stipulation not to place it upon a window fronting the street. In return, Malchen brought him a plateful of dumplings, but it is not stated whether he was enjoined to eat these in secret. Jacob's record in mathematics and the classics now suffered a decline, but the blissful hours spent with his first sweetheart compensated him for lowered scholarship.

The lad looked forward to the summer as the time when release from school would give him more leisure for Malchen, but in the summer his idyl was over. For Malchen, lovely but poor, was abruptly engaged to marry a gentleman, elderly but rich. Young Henle now passed through a period familiar to so many adolescents, when a feeling of suffocation clutches the heart and the gray world is all ennui, when the brooding melancholy of the oppressive day is followed by the deeper anguish of the endless night, and to the memory of lost pleasures is added the realization that these joys have vanished forever.

In this stage, much of the world's poetry is born, and Henle wrote this lamentation to the summer:

O Summer, thou hast taken from me
All my happiness,
And brought me nothing
But sadness and sorrow.
Shall I rejoice with the swallows
Who returned to us,
When a beautiful bird
Has flown from me forever?
Sing, O sing, thou nightingale,
Sing your songs in the bushes;
The sound of one sweet voice
I shall never hear again.
Shalt thou, sweet air of spring,
Caress me with thy flowery fragrance?
Sweeter than all the flowers' scent,
Was the breath of my sweet one.
O heavens, with your azure blue,
Cover yourselves with rainy clouds!
For her eyes too swam in tears,
When our ways were parted.
What care I for the green forest,
Since no longer she walks besides me?
Can I enjoy the flowery meadow,
When she is no longer with me?
O Summer, thou hast taken from me
All my happiness;
O thou cruel summertime
Hadst thou never, never come!

Many other lamentations fell from the sufferer's pen, and Henle closed the cycle of his love-songs with this dirge to the flames:

To the Fire do I consecrate my songs,
Which I sang in my happy days;
With each spark that goes out,
My sweet hopes go to their graves.
So burnt my heart in bright flames
For Thee; thou scornedst it, then it broke;
When, oh when, will come the time
Which will disperse its ashes?

On the day of Malchen's wedding, Henle's tortured spirit would not permit him to remain in town, and he received his parents' permission to visit some of his friends in Mainz. A boy's love is acute, but rarely fatal, and Henle recovered. With the reopening of school he returned calmly to his benches, and graduated peacefully.

At eighteen, he stood at the cross-roads of life, undecided which way to turn. His friend, Ludwig Lindenschmitt, who even then was an antiquarian enthusiast, urged the talented youth to study the Germanic authors, and become their historian. Henle was impressed with this suggestion, but he thought too of law, and was also inclined to become a preacher. At this critical juncture, Johannes Müller again crossed the young man's path, and the decision was made. Not literature, nor jurisprudence, nor theology, but medicine was to be Jacob Henle's life-work.

II. THE MEDICAL STUDENT

In the autumn of 1827, Jacob Henle matriculated at the University of Bonn—he was no longer a boy at home, but an academic citizen. The day after his arrival in the university town, he received a dinner-invitation from Johannes Müller and his wife—for Johannes Müller had not looked at Nanni Zeiller in vain. Their housekeeping was unpretentious, as the professor's salary was meager, and Nanni's dowry was nothing but a song-book. They plied Henle with questions about the folks in Coblenz, and were very friendly. After dinner, Henle and Frau Nanni sang together—and perhaps he thought of the days when he used to sing with Nanni's sister. Reticent and introspective, Johannes Müller was a man apart; he did not join in the festivities held in his home, but his face lit up when he heard his wife singing. Henle came frequently, relishing the scientific talks with Müller, and the duets with Nanni.

Henle thoroughly enjoyed his introduction to university life; he subscribed for a season-ticket to the theater, became expert in dancing, took riding lessons, and never refused to attend an affair that promised to be jolly. He was proud of his social debut, and wrote to Marie:

> Can you imagine, dear heart, little Jacob in a frock coat and cravat, holding a teacup gracefully, alone among seven ladies, conversing politely about balls in Bonn and Coblenz—can you imagine your stiff brother like this, at Professor Treber's? I did not feel exactly comfortable as long as there was no other masculine being in the room, but I was sufficiently composed to bow properly, and without dropping anything or smashing any crockery, I managed to sip down two cups of tea.

Even in the midst of accident, Henle exhibited a serene countenance to society. Once, while standing up and conversing vivaciously with the lady of the house, his piece of cake fell from the cup and saucer which he was holding in his hand. In stooping to recover the delicacy, the treacherous spoon also fell. Instead of being flustered and offering a thousand apologies Henle said to the hostess, "Now that the cake and spoon are already on the floor, may I place my cup there also?"—and thus the situation was saved by laughter.

Henle was among those scheduled for Professor Bischoff's grand ball, but he found his raiment inadequate for the occasion. His comrades came to the rescue, and from one he borrowed a hat, another loaned him a cravat, a third came forward with a collar, and a fourth furnished a vest. It always rains at the wrong time, and Henle hesitated to expose his faultless outfit to the Bonnian mud and the threatening weather. A fifth friend, however, permitted Henle to mount his back, and off they went in the darkness of the night. Any honest horse would have halted in front of Bischoff's house, but this human steed refused to drop his rider and galloped with him among the assembled guests, creating what he expected—a sensation.

Henle joined the famous student society, the Burschenschaft, and the members hailed the merchant's son with joy. They liked his tobacco, and smoked his cigars; they ordered coffee at his expense, and showed a preference for his beer and wine; they praised his ham, and were enthusiastic over his sausages. In fact, Henle found himself so popular, that he soon withdrew from the Burschenschaft, and expected to hear no more of it.

College life appears to be unusually expensive, for nothing is more characteristic of students than the persistency with which they write home for money. Some students are prosaic, and simply say they need more money for food and rent, while others are inventive and announce they require an extra allowance to purchase a celiac axis. As evidence that Henle was a regular fellow, let us submit the following document which he transmitted to his parents:

> Money! Money! Money! I have nothing, and I owe my friend Mathieu ten dollars. Money! I paid forty-six dollars for tuition, much for books, and twenty dollars for housekeeping. Money! Otherwise things are well with me, but Money! Money! Money! Last Sunday I visited Müller who grows more congenial and friendly from day to day. He gave me some good advice. I remained there until evening. Professor Pugge, with his wife of eight days who has a very nice voice, came in the afternoon and invited me. But Money! Money! Yesterday evening I visited Pugge, where I met many fashionable students, and the professor's parents-in-law, Hasse and his wife—Hasse is one of the most prominent Jurists here. I sang several songs with the lady of the house and remained until half past ten. I also made the acquaintance of Prof. Hasse's son, a young man of my age, and Fuchs

> too, I learned to know. I think we shall become friends. Money! Money!
>
> You see now that I could live here in dulci jubilo if only I had money, only Money! Money! but quick! Although I am screaming for money, I must also write about something else. I really cannot use my cloak, and when I assure you of this, you will simply have to trust me and take my word for it. I need eight yards and a fur collar. When you send this, also send a pair of shoes, also my calendar which I left at home by mistake, a few pounds of sugar for the evening tea, and a good Mainz ham. But above all—Money! Also forward to me Biot's Experimental Physics in four volumes. The next time I shall write you about the university. Money! Money! Money! Cloth! Fur Collar! Calendar! Biot's Physics! Ham! Sugar! Money! Money! Money! Money! Ham! Money! Cloth! Money! Fur Collar! Money! Calendar! Money! Physics! Money! Sugar! Money. Your eternally loving, Jacob.

While we were recording instances of Henle's social success, a suspicion might have been born in the reader's mind that the matriculant was unfaithful to the curriculum. The passageway to medicine is through the labyrinth of anatomy, and many turn away in despair, but Henle entered with ease. He wrote his parents:

> I derive so much pleasure from these studies that I cannot understand how my good genius permitted me to waver so long, before it brought me upon the right path. What others regard as dry stuff—such as the necessary, thorough and almost minute observation of all the parts—fills me with astonishment and joyous admiration of the manner in which it leads up with one end in view, even in the smallest particulars. I know of no better food for imagination than the beautiful formation of the human body, constructed of individual bones and muscles, which I know accurately and can put together. I know I shall learn something sensible, I shall positively not be a bungler.

From the first, he began to think anatomically and physiologically; in the second semester he illustrated Müller's work on glands, and became active in the master's laboratory.

Vacation time approached, but instead of packing his belongings, Henle lay in bed with a wounded cheek. As a duelist he was not a success. It is true, he was once victorious, but as he stood there with legs apart, proudly lowering his rapier, its point pierced his shoe and cut his foot. When Henle finally presented himself at home, nothing seemed so conspicuous about him as the *schmisse;* his parents were horrified and did not permit the mutilated student to show himself in the streets of Coblenz. For the first time in his life, Henle felt the weight of parental wrath—his mother was especially shocked and angry—although it is difficult to see how a German student could have avoided the inevitable *mensuren.* Sainte-Beuve once fought a duel under an umbrella, but Henle found himself under a cloud. Perhaps if he had been more lucky, his parents would have been less indignant. At any rate, there was a rift in the Henle lute, and with impatience the household awaited the coming of the new semester which would call the student away to new duties.

Henle continued his studies at Heidelberg, and was delighted with his teachers: Naegele, whose description of the obliquely contracted pelvis—one of his specimens was that of an Egyptian mummy—is still known as the Naegele pelvis; Chelius, who introduced the surgical and opthalmological clinics into Heidelberg, and whose Handbook of Surgery was translated into six languages and reprinted many times without criticism until Stromeyer pointed out that it didn't contain a single original idea; Puchelt, who adhered to the School of Natural Philosophy, and whose reputation disappeared with the School; Arnold, after whom a dozen structures have been named, such as Arnold's canal, Arnold's ganglion, Arnold's nerve; Tiedemann, who was Heidelberg's first professor of anatomy and physiology, but whose chief claim to remembrance is perhaps the monograph on digestion which he wrote in collaboration with Gmelin.

Anatomy was Henle's favorite subject. He prepared animal and human specimens, frequently corresponding with Müller, who stimulated his young friend by keeping him informed of his work and writings. Henle practiced assiduously in the clinics, and experienced the felicity of being called Herr Doctor—by charity patients. He tried out his first blood-letting on a female, and relates that although on account of the roundness of her arms the veins were hardly visible, yet he completed his venesection without any misfortune. After having cupped three times, he permitted himself to cherish the hope that if he should fail in medicine, he could be a successful bathkeeper.

A medical student is apt to complain that his course consists of an excess of quizzes and a scarcity of clinics, but Henle wrote:

> The professors surpassed my expectations in diligence, politeness and affability, and everyone under whom I study understands his subject thoroughly. However, I have no occasion to regret that I did not come here earlier, for while the practical end is well represented, the preparatory and theoretical courses are poor. Without laying a scientific foundation, everyone rushes into practice, and the results of this superficial and empirical method will come to the surface as soon as the guiding hand of the teacher is withdrawn. The machine-like prescription-writing is certainly not our highest goal, and whatever such a mechanical man appropriates through many years of experience can soon be equaled if we are willing to seek reason and ground. This is the only way by which we will be able to accomplish something independent, and will not be compelled to follow blindly what others tell us from their experience. The practitioner who is merely concerned about practice, may through some luck and *savoir faire,* attain a decent income, but he will never accomplish anything for his science, and I do not call him fortunate, who is satisfied with just that.

Toward the end of his stay in Heidelberg, irresolution again assaulted Henle. Vacation arrived, and he was still undetermined whether to plan a clinical or academic career, but he expressed his indecision charmingly:

> I am still undecided regarding my future. Much draws me to the practical, especially the position of a physician who knows how

to make friends and inspire confidence. On the other hand, I have the knowledge that I can pursue the career of a teacher, and to sit in a lecturer's chair with believing open-mouthed youngsters in front of me, devouring with pointed pens every word as though it were an oracle, and laughing at every poor joke which I surely will not fail to make *ex officio*—this is not a bad picture. But the years of a privat docent! the years of dependence and huddling! and on the other hand, the seven first lean years of practice! In short, I am and remain undecided.

In such a crisis, Johannes Müller was the man to whom to appeal, but the inspired teacher was away in the land of Leeuwenhoek and Swammerdam. Upon Müller's return, just before the reopening of classes, Henle hastened to his mentor, and laid his problems before him. There was no wavering in Müller's devotion to pure science; in the presence of a talented youth, his flaming enthusiasm swept aside all hesitation and Henle followed Müller to Bonn, with the settled purpose of dedicating his life to anatomico-physiological research. The comfort that comes from resolution is evident from Henle's communication to his parents:

> Recently I had the good fortune of making an anatomical discovery, which when I introduce it into the medical world, will make for me somewhat of a name. Müller to whom I spoke of it is much pleased and he confirms my opinion, so I may now call him as witness. If Müller goes to Paris this fall, as he expects to, I shall make my further investigations and write down my findings partly in Coblenz, and am looking forward with much pleasure to spending several weeks with you.
>
> Since my arrival here, I have become convinced that I should take up the teaching profession. Since my renewed intercourse with Müller, my desire for anatomy, which I will be able to pursue only as docent, has awakened once more. I find that I know much more about it than I gave myself credit for, and the investigations which I conduct upon Müller's instigation convince me that I do not lack talent. Furthermore, there are other conditions which draw me to this career. First, Müller's friendship, which

can be of so much help to me. Second, I can make good use of my skill in drawing. Third, although I cannot deny that it will take some years before I become independent, yet I need not hurry especially. And now, that I have once more gained self-reliance, and hope to accomplish something worth while, I also have the courage to ask for your parental love. Fourth, I see too, how my entire being inclines me more and more to the life of an instructor. I am daily growing more sedate, more quiet, more one-sided, and am losing more and more the qualities necessary to the practical physician. I should not like to choose a profession that would make it necessary for me to take off my dressing-gown before eleven o'clock in the morning and allow my pipe to go out. Fortunately, I find the other reasons which I am giving you conclusive enough, otherwise you might blame this last one for my decision. Finally, there is not a single one of my acquaintances, either wise or unwise, who does not recognize my plan as a very good one, while Müller greets my decision with hearty joy.

Now that I am clear regarding this important question, I have decided to remain here over this winter. The reason for this I need not explain to you. The rich clinics in Berlin do not attract me any more; I intend to devote myself exclusively to anatomical studies and researches, and where can I do it better than here? I can do my work under the very eyes of Müller, and call upon him for advice whenever I am in the slightest doubt; his instruments, microscopes and books are entirely at my disposal.

I am also on good terms with Weber, and he has already spoken to me about some preparations for his lectures, and in return has promised me as much material for dissection as I need. I am therefore looking forward to a very pleasant period, where I can lay aside all examination-studies, and busy myself entirely with my favorite occupations. In the morning I shall do anatomy, the afternoon I shall devote to dissection, either for myself or for Müller, and in the evening I shall read. I cannot tell you with what expectations I am looking forward to this time. And still more. Müller proposed to me material upon which I can work and perhaps submit to a Journal; in fact, Müller asked my coöperation in a larger work, which it would not be advisable for one person to perform, and then I shall allow myself to be led into the world by him and shall hang my name to his, and let him drag me along. This is all really too beautiful, and I don't know whether I am right in telling you everything, as I myself fear that Fate will not permit me so much bliss.

My life plan, at present, is as follows: At the beginning of vacation, I contemplate taking my doctor's examination; during vacation I shall write my dissertation, and around Christmas I will permit the doctor's cap to be placed upon my head. I shall stay here throughout this winter and work hard, and after Easter I shall go to Berlin to prepare for the State Examination. I shall next look for a place and try to advance as rapidly as possible, then shall marry a young, beautiful, wise and rich girl, who speaks French, plays the piano and knows how to manage horses.

Now I beg you to let me have your opinion regarding these plans. If I, perhaps, am a little broad or confused in my explanations, you must forgive me, for I am writing this note in the class of Professor Bischoff, whose monotonous phrases ring into my ears from time to time.

The keen edge of remorse over wasted hours never cuts more deeply than on the student's day of reckoning—the day of final examinations. But destiny is not always decided in classrooms. A student who passes his examinations *magna cum laude* is not necessarily successful in the postgraduate school of life. What happens to all the valedictorians? Many of them become employees of men who failed in college. It would be piquant to recite a list of celebrated individuals who were the despair of their forgotten teachers. Nevertheless, it should not be considered discreditable to pass with the highest marks. An examiner who perused Henle's papers, expressed himself to the effect that during his lifetime he had not seen their equal, and Johannes Müller was so impressed that he invited the brilliant graduate to accompany him on his long-planned visit to Paris.

It is a prize platitude to say that there is something about a trip to Paris which appeals to everyone. It is not difficult, therefore, to imagine Henle's joy; he was naturally of an enthusiastic temperament, and to travel with Müller was the rarest of privileges. Arrived in Paris, the two Germans conversed only in French, and swelled the applause at numerous operas and theaters. Henle was not pleased with the French—that is, with the male portion, but he chanted pæans of praise for the French girls, asserting that in grace, dress and poise, they could serve as models for all Europe.

At Müller's approach, the laboratories and cabinets of the French naturalists opened in welcome. Cuvier, who was then the potentate of French science, placed his own workroom at the disposal of Müller and Henle. Müller, who achieved immortality on a frog's back, had proved the correctness of the Bell-Magendie theory of the spinal nerve-roots, and he invited several distinguished Frenchmen to witness his demonstration. Alexander von Humboldt, who was in Paris at the time, was also invited, and Henle, who of course assisted in the experiments, has left us this glimpse of his illustrious countryman:

> Humboldt has gone again *bien satisfait des jolies manœuvres* which we had the honor to perform before him. He claimed to be delighted at having made my acquaintance, which, probably, was just prattle, and he told me the story of a young man, whom I didn't know, that he had married, regarding which I expressed inhuman joy. At the end he left five francs, most probably a tip for me. I, however, brought the money proudly back to him, and in return for this I received my handkerchief, which he pocketed by oversight. He brought with him a number of other prominent scientists, whom I now know personally, and upon my return to Bonn, I shall have something to boast of. You should have seen the way we fixed up our poor room for the reception of these important guests. First of all we put everything in order. But then we found that a hole in a chair, there a tear in the table-cover, had to be covered with books, and so we chose the system of artistic disorder, as we preferred to appear careless rather than poor; it of course would have been differently arranged, if dear mother had announced that she would visit us. His Honor, the Minister, was placed upon an armchair covered with red flowered velvet cloth, the other gentlemen on similar chairs only filled with feathers, so their dignity might sink a little deeper. Müller and I camped on two cane chairs, which together numbered seven legs. We two

were dressed entirely in black, including our linens, as our *femme blanchisseuse* disappointed us *perfidement.*

Upon his return to Bonn, Henle worked with such diligence upon his doctor's thesis that some of his friends were neglected —but when evening came, he found time to sing with Frau Nanni. Henle's increasing intimacy with Müller may be sensed from certain passages in his description of his graduating exercises:

> Graduation has occurred, and was very solemn. I appeared in Müller's breeches and my own calves, which excited general admiration. . . . The dissertation met with much approval, and I myself, am satisfied with it. As I remarked, I am getting always friendlier with Müller, and our mutual tenderness is reaching the stage of mush.

Instead of the usual graduation dissertation—an academic review of ancient and modern opinions on a given subject—Henle presented his teachers a research-essay based on his own dissections of the optic membranes in man and various animals. Henle's *De membrana pupillari aliisque oculi membranis pellucentibus* was not a thesis wrung from an unwilling student by the exigencies of graduation, but a contribution to science that foretokened a future discoverer.

III. ADVENTURES IN BERLIN

One obstacle still lay in Henle's path—the State Examination. The young man sighed as he thought of it, for this meant an enforced renewal of his acquaintance with subjects which no longer interested him—symptoms, diagnosis and treatment. Dr. Henle had nothing to do with practical medicine. The clinic was now foreign territory to him—his home was the laboratory. Besides, the State Examination could be taken only in Berlin, and thus it was necessary to part from Müller, whose note of farewell lay before him:

> It is true, then, my dear Henle, that you are to go. I miss your dear society, but I know that you have left us that you may progress further. I hope to hear from you real often. I shall certainly not let you wait for an answer. Go then, accompanied by a thousand good wishes and by our love, and return to us the same affectionate friend.

Henle entered Berlin a stranger, but armed with Müller's letters of introduction to such scientists as Rudolphi, Schlemm, Dieffenbach and Romberg; from his father, Henle carried letters to commercial and juristic groups. A man who relies upon letters of introduction for his friendships, is apt to be solitary—but Henle was always a social animal. Merkel says that when Henle was a short time in Berlin, the circle of his acquaintances changed considerably, for the families to whom he had been recommended, receded into the background, and the friends he found for himself, stepped into their places.

Among these friends was a certain Fräulein whose charms effaced the memory of Malchen. It is asserted that Henle was infatuated at first sight—"a glance from her was lightning and a thunderbolt at the same time"—and he was fully determined to ask her in marriage as soon as he obtained an income. Some women wait, and others don't. While Henle wooed and postponed, a landed proprietor wooed and proposed—with the usual success of wealthy men. This was Henle's second shock, but Wertherism was antiquated, and suicide did not follow. On the contrary, within a short time he wrote that he experienced the sensations of a bird on a branch who peeps into the room where stands his late cage.

Another friend of this period was Felix Mendelssohn. It was Henle's privilege to witness the origin and development of some of his compositions, and the musician became so attached to the scientist, that when he passed through Coblenz, he paid a special visit to Henle's family. Sister Marie's talent for music eclipsed even her brother's, and Mendelssohn enchanted her with a private performance of the overture to Midsummer Night's Dream, which he had composed in his seventeenth year, and which carried him to fame's pinnacle. Some years later, Henle and Mendelssohn might have been related by marriage, but when Henle proposed to one of the Mendelssohn girls, he discovered she was already secretly betrothed.

In spite of the imposing examination which loomed before him, Henle entered into the social life of Berlin with zest. He was always good company: he could chat superficially on trivial topics, knew how to play whist with the ladies, how to drink tea leisurely, and how to smoke a pipe comfortably.

He would have been content, if only Müller could have been with him—and then, with dramatic suddenness, Müller did come to Berlin, for Rudolphi, the professor of anatomy and physiology in the University of Berlin, unexpectedly died, and Johannes Müller was appointed his successor, thus becoming, in his early thirties, the central figure of German medicine. Müller and Henle hailed each other with joy and a renewal of their friendship meant a renewal of work. Müller now founded his epoch-making *Archives of Anatomy, Physiology, and Scientific Medicine,* familiarly called Müller's *Archiv,* which was the most influential journal of its kind until displaced by the periodical founded by one of Müller's pupils—Virchow's *Archiv.* Henle's name appeared conspicuously in the prospectus of Müller's *Archiv;* he was, in fact, the managing editor. Müller drew Henle still closer to him by appointing him his assistant at the anatomical museum. Henle went through the state examination without mishap, and soon celebrated his release by writing articles for medical dictionaries and encyclopedias, and by immersing himself in research.

Now that Henle was a teacher, every academic upheaval interested him—he might be appointed. When Ratke was called from Dorpat to Halle, as successor to the deceased Meckel, Henle reasoned as follows:

> Through this the professorship in Dorpat is open, and as Russia likes to recruit from here, and as there is hardly a surplus of physiologists, it is possible that I will get the place at Dorpat.

While waiting for a stray professor's chair, Henle deemed it expedient to utilize his artistic talent by offering his services to the academy of art, and he wrote his parents an account of his adventures in pursuit of this position:

> I was glad to give you pleasure by my appointment as prosector, especially as the joyous expectation of the other post may not be realized. I shall have to tell you the entire procedure, so not to have you think that I am as frivolous as may appear. When the place became vacant about three months ago, I foresaw but one who could contest it with me, and that was my friend Froriep. I went to him and spoke as Abraham spoke to Lot: If you wish to apply for this position, let us not be enemies; you have the qualifications for it, you are a good draughtsman and a pater familias, and therefore, I shall step aside, although I have been requested to apply. My behavior at the time was considered noble. After much controversy Froriep wrote to his father—it must be said a real politician—who advised him not to apply—that is, never mind the 400 thalers. Froriep confessed to me that he was heartily pleased over this, as he need not consider the income, and the work at the academy would distract him. I apply and all is well. I leave, I return, I inquire, and Privy Councilor Schultz, Professor Rauch, and Director Schadow, all assure me that I will be successful. Only the matter proceeds slowly, for the Minister needs time, as always. All of a sudden, old Froriep appears, calls upon the Minister and the Councilors, and my friend sadly informs me that he is compelled to make an application for the post.
>
> My view of the affair, as far as I am able to judge, is this: old man Froriep informs the authorities that his son has been professor for three years, and still receives no salary. The Minister recognizes his complaint as just, and even if he does not, he agrees with old Froriep, with whom he is on good terms. The Minister, however, as always, has no money to dispose of. Then he reminds himself of the yet unfilled post at the academy of art, with 400 thalers attached. I, the only applicant, am a young unmarried man, who has just entered into State service, and already has a salary of 500 thalers, and I ought to be satisfied with this. The academy's 400 may be utilized to stop the mouth of someone else for the time being, and Papa Froriep brings home with him a request and, most

probably, a promise of success. Whether it is right for Froriep to take back his promise and compete with me, I shall not try to judge. If it is a crooked way, then it is the old man's fault, and I have set my pride upon it, that our friendship shall not be shattered on this rock. I told Froriep that I shall pursue my course as I have begun, as I may be able to use even a negative answer for the future. I have not, however, attempted to use any subterranean means, and our applications lay fraternally together before the Minister. You can readily understand that under these circumstances there is little hope for me.

My relationship with Müller is such as I imagined it, and that is saying a great deal, as I imagined something very beautiful. I always seek to do more than is expected of me. . . . I see more and more, what an invaluable treasure, the tested friendship of this excellent man really is. I now have an assistant, in the person of little Friedlander, whom you know. He assists me with my work when necessary and in return for this, he enjoys my special instruction in dissection, and in return for this again I enjoy an occasional dinner with his parents. He is very industrious and modest, and I think we shall be satisfied with each other.

The diplomacy of the elder Froriep was successful, and Henle reported to his parents:

The academic affair is finally decided, and it has brought me a great deal of disquietude and some pleasure. I realized very soon that this was not the time to indulge in high-minded sentiments, and without giving myself any false hopes, I determined to bring my competition with Froriep into the open. I, therefore, submitted my drawings to the academy, and personally called upon the individual members of the senate, and found that they were unanimously in my favor, as they considered me especially qualified for the post, and they requested the Minister to appoint me.

In the meantime, the Minister, paying no attention to their wishes, appointed Froriep temporarily. The entire academy resents this act, and there is talk of protest. That of course would be futile, as the Minister will not alter his decision. It is, however, enough satisfaction to me, and in other respects may prove very useful, as you can readily see that the Minister will have to make good this injustice done to me. In fact, when I called upon him recently, he was very cordial and promised to see to it that I should better my position through a more scientific occupation, than that which was recently vacant at the art academy. According to this, I can even demand an extraordinary professorship, and that certainly would be more advantageous to me than the little distracting by-office. On the whole, I can say that my old luck has not deserted me. I gained, if not in money, in prestige, and I can step forth with unsullied pride, side by side with my successful competitor, and the fact that our friendly relationship has not suffered through this affair, is something which, all who know the circumstances, count in my favor. Müller says he is glad for his and my sake that I did not appeal, and that too is of importance.

When Henle applied to the authorities for formal habilitation as privat docent, he expected a routine confirmation in due course of time. In reply he received an unpleasant reminder that he was an ex-Burschenschafter, and he was informed that his political past was under investigation. This attitude of the State was entirely unexpected, and filled Henle and his parents with consternation. But a calm review of the situation relieved their panic, for they saw no genuine reason for alarm. Of course, the present misunderstanding was disturbing, but after all, Henle's participation in the Bonn Burschenschaft had been so slight, his exit so speedy, his subsequent devotion to science so complete, and his career so promising, that it was unthinkable that he should be condemned to any punishment severer than a reprimand.

But society must be saved, and church and state must be protected, and prosecutors must prosecute—and therefore the criminal inquiry proceeded apace. As the evidence was being sifted, exciting rumors leaked through the sieve: one day the academic circles of Berlin heard that both Müller and Henle had been arrested, but those who sought verification of the story, found the professor and his prosector at work in the Anatomical Museum. After a comparative lull, Henle would persuade himself that danger was over—until the sudden imprisonment

THE MOTHER OF HENLE

THE YOUTHFUL HENLE

of one friend after another, no more guilty than himself, stirred new terror in his heart. During this unsettled period, torn between hope and fear, uncertain whether the morrow would find him a state teacher or a state prisoner, Henle's scientific output was naturally diminished, but he produced at least one essay which won the enthusiastic admiration of Alexander von Humboldt.

In the meantime, there came to Henle, a friendly and highly respectful letter, from the Ministry of Dorpat, offering him the professorship of human and comparative anatomy, zoölogy, physiology, general pathology, and pathological anatomy. However, there was compensation for this work, for the letter explained that after twenty-five years of service, the professor is retired with full salary, "which he may spend where he pleases," and after his death, his widow receives a pension.

The latter item held little lure for a bachelor, and Henle's reply was indefinite. Early in the morning of the second of July, 1835, as Henle lay comfortably in bed, dreaming, perhaps of the Dorpat proposition, unexpected visitors entered his room. In that summer dawn, they affixed seals to the door, and took Henle with them. Throughout the day, Müller waited in vain for his prosector, for he had been transferred to the most famous institution in Berlin—the Hausvogtei. His cell swarmed with vermin, there was nothing to read except the Bible, no one came to see him, and he did not have a cigar.

A landlady is usually ubiquitous, but unfortunately, the sympathetic Frau Hegel failed to live up to the tradition; when the police arrested Henle, instead of being present, she was out of town, and the deed was witnessed only by the servant-girl. Now this servant-girl, in spite of her humble position, possessed a mind corresponding with that of certain eminent jurists—she recognized no distinction between a political prisoner and a common prisoner. She knew that no good man is carried off at dawn by the police, and she shuddered when she thought how often she had swept this criminal's room—unaware of any danger. As the day advanced, callers began to inquire for Henle, but ashamed to acknowledge that an inmate of her house was in the hands of the authorities, she covered the official seals on the door-knob with her apron, and persistently announced that the doctor was out. It was due to the intervention of this well-intentioned servant-girl—truly, a pillar of society—that Henle passed many weary hours in the Hausvogtei without seeing a friendly face. As soon as his new residence became known, numerous friends, with attentions and gifts, made his position as bearable as the authorities permitted.

During this episode, the Dorpat officials pressed for an answer, and were startled to learn that their intended professor was a prisoner. Efforts to have Henle released from his lice-laden cell, pending the result of the Burschenschaft investigation, were long unsuccessful. Müller, impracticably lovable, did not help matters much by his constant reiteration that Henle was indispensable as a prosector; the Gustav Magnus family rendered more effective aid by their pressure upon the proper authorities, but it was probably due to the powerful intercession of Humboldt that Henle was liberated.

After four weeks of prison-life, the genial young man again joined his many friends, and the rejoicing was great. Unnumbered visits were received and returned, congratulations flowed in from all sides, champagne ran like water for him, Berlin pancakes were stacked in hills before him, men embraced him, women wept with emotion, and in the midst of a large assemblage, a pretty woman came forward and kissed him—and with characteristic male exultation Henle notified his parents that for rewards like this, he would gladly spend another month in prison. Müller informed him that his four weeks in the Hausvogtei brought him more popularity than if he had written a thick book. The climax came when a carriage stopped in front of the released prisoner's door, and a gentleman accompanied by a liveried footman mounted the three flights of stairs that led to Henle's apartment. The caller was one of the European powers —Alexander von Humboldt. His wishes altered the decisions of governments, and kings bored him with their society. To have

Humboldt climb three flights of stairs to see you, was an epoch in a man's career. But this drama did not end with the climax—it was followed by a farce. In the liveliest thoroughfare of Berlin, the prosecutor Kamptz greeted Henle affably, and explained for an hour that he personally was convinced of the innocence of the Burschenschafter and how differently all would have been if he had the sole authority—and passers-by could hardly trust their eyes when they saw this peaceful promenade.

Yet the investigation was by no means over, and in the harassing months that followed, Henle's mother went to her grave without knowing what fate was in store for her son. It must have been the extenuating circumstances of the case which kept the judges so long at their task. The problem was indeed a delicate one, for it required due exercise of the judicial mind to determine a fitting penalty for a student who had joined a students' organization, but instead of remaining to plot against the government, had withdrawn when he noticed his fellow-conspirators were too generous with his tobacco. It was not until the fifth of January, 1837, that this verdict was delivered: deprivation of state office, and six years' incarceration in a fortress. If the sentence seems severe to us, we may console ourselves with the reflection that in every city throughout civilization to-day, there are judges eager to impose similar sentences upon those whom they deem guilty of intellectual insubordination. Had Henle been without protection, his career would have been blasted at its outset, but powerful influences, among them being Humboldt, worked for his pardon, and on the second of March, the shadow was lifted.

Then began a remarkable period of productivity in which Henle became one of the chief builders of modern medicine. His contributions to Müller's *Archiv* were sufficient to make the reputation of a dozen professors. In those days the Berlin presses printed monographs, signed J. Henle, which opened up new paths to science. Had he never accomplished anything beyond his researches from 1837 to 1840, the name of Jacob Henle would still rank with the foremost investigators of modern times. Yet Henle was not happy in Berlin. Unable to forget the vermin and the Prussian officials, he itched for a professorship in another land. When Henle's co-worker in Müller's laboratory, Theodor Schwann, was appointed professor in Louvain, Henle watched the departure of his young friend with envious eyes.

In the early months of 1840, came Henle's turn: he received the offer of a professorship in Zürich—and a hint not to interest himself in Swiss politics. With eagerness, he accepted the proposition, and set out for Switzerland—and Destiny waited across the border.

IV. THE ZÜRICH PERIOD

The Switzerland of the present is a well-ordered tourist's paradise over which shines an array of Baedeker stars, but in Henle's time the beauty of its lakes was defiled by politics, and wrangling men impaired the majesty of its mountains. In Zürich, the controversy was precipitated by D. F. Strauss, the storm-petrel of theology, whose *Leben Jesu*—Englished by George Eliot—is one of the classics of freethought. The liberals of Zürich, being temporarily in the ascendant, were daring enough to appoint Strauss to the chair of theology, but the threatened invasion of the Tübingen rationalist aroused such protests, that although the administration pensioned Strauss before he commenced his duties, the forces of reaction were not appeased, and in the upheaval that followed, the conservatives rode into power with the determination to punish the young university—in revenge for the invitation to Strauss. From this imbroglio, Henle was glad to retreat to the calmness of his dissecting-room.

When Henle arrived in a new town, before settling down to work, he found it necessary to relax. During his first winter at Zürich, he spent more time in the tavern than at his books. His evenings were a succession of balls and entertainments, followed by concerts and theatricals. In one of his letters, Henle describes the Swiss system of chaperonage:

> Everyone dances. Old ladies, mothers and aunts are seldom present, and if they are, they go home at eleven, and consign their daughters to the care of a young man who is not too much of a stranger. On the way to the ball, a servant precedes with a lantern, so that the stockings should not be soiled. On the return, this foresight is dispensed with, and with it the servant. Is this not idyllic?

The deluge of merriment was tinctured with adversity when Henle found himself compelled to change his lodgings—because his landlord Hagenbuch expected him to court one of his daughters. However, Henle had fallen in love with women in Coblenz and Berlin, and he was not insusceptible in Zürich. He was irresistibly attracted to an army captain's daughter: he proposed, and was accepted, but the first cold embrace appalled him. It soon transpired that the girl already had a lover whose passion was on the wane, and she resorted to the expedient of winning him back by arousing his jealousy; after success had crowned her efforts, Henle was quietly dismissed, and the guileless professor thus found himself a victim of one of the oldest tricks in love's tangled game.

The ardent-hearted Henle was deeply wounded, and sought solace in music. Already skilled on the violin, he now took lessons on the violoncello, and after mastering the bass member of the family, became conspicuous in the musical circles of Zürich as singer, violinist and 'cellist. The same fingers which could dissect a cadaver so adroitly, knew also the wondrous secrets of four strings of catgut. Upon one occasion, a theatrical company to which Henle belonged, prepared for a public performance, and among the names posted on all street-corners of the town, was that of the versatile professor of anatomy. Sober-minded citizens, including Henle himself, felt that this was carrying virtuosity too far.

Throughout the career of Henle, the golden thread of friendship ran unbroken, and it gathered its richest strands in Zürich. For many years that boorish genius, Johann Lucas Schönlein, made medical history in the Swiss city. Typhus abdominalis and typhus exanthematicus are terms of his devising; he described peliosis rheumatica so well that we call it Schönlein's disease; he discovered the cause of favus to be achorion Schönleinii, and as he disliked writing, he described his discovery in twenty lines. But in 1840, the mighty Schönlein, founder of the Natural History School of Medicine, retired from Zürich to reap homage and money in Berlin, and into his chair climbed the young clinician, Carl Pfeufer. Pfeufer's arrival in Zürich coincided with Henle's, and before long the two new teachers became acquainted. It was friendship at first sight, and with joy Henle wrote:

> Pfeufer is one of the most charming men I ever met, merry, exceptionally witty, yet genial, modest and full of ambition. He is young and advanced enough to be able to discard the obsolete—in other words, he is the man I need.

The anatomist and the clinician talked matters over, and decided it was time to revolutionize science. Accordingly they founded the School of Rational Medicine, and its fearless mouthpiece, "The Journal of Rational Medicine," trumpeted abroad the progressive ideas of its editors, and blasted many venerable hypotheses which had survived from the days of Stahl. But Henle's most important literary undertaking, during the Zürich period, was his "Handbook of General Anatomy."

Every university should be a capital of the Republic of Arts and Sciences which recognizes neither frontiers nor partisans—but the University of Zürich lay in the political path. Perhaps the study of anatomy promotes impartiality, for Henle complained without bias:

> Rankling with fresh hatred, the two antagonistic parties, the aristocratic-religious and radical, face each other, and both are tearing us apart: the reactionaries inquire whether the university

is worth its expense, and the radicals, who consider themselves the enlightened ones, resent our non-partisan attitude. . . . Even with diligence, patience and ability, it will never be possible to make anything out of our university in the face of such a struggle. . . . There is only one good side to the situation, and that is that we all stand solidly together. Many little animosities and much raillery have been forgotten in the face of the common foe, and we spend the beautiful summer evenings and Sundays out in the open, and amuse ourselves by scolding and jests at the expense of the powers that be.

Henle's passage through the university was marked by a series of calms and tempests, but each time he triumphantly reached his goal. When entering upon his duties, he was much pleased with the new and practical anatomy-building, but was disconcerted to learn that one microscope had to serve for all students. The authorities came to the rescue by permitting him to order another, and they placed at his disposal the sum of 480 Swiss francs to be spent exclusively upon instruments.

Henle was greeted a trifle pompously, yet affably enough, by his prosector, and this assistant would have sufficed for most professors, but Henle never considered a pretentious demeanor a substitute for anatomical knowledge. During a certain semester, he intimated that his prosector be removed to another department, and after adding a few other suggestions in the form of an ultimatum, Henle went upon his summer vacation—little expecting to resume his chair, for authorities are usually deaf in the presence of requests. Upon his return in the autumn, to his surprise he found that all his wishes had been met: the appropriation for the collection of comparative anatomy had been secured, and not only had the prosector been transferred, but in his place was Albert Kölliker.

From that moment Henle became a great teacher, because he had a great pupil. Kölliker was a Züricher with a Heidelberg diploma, but his real education was gained in Berlin where he had sat at the feet of Johannes Müller, and during his prosectorship under Henle he contributed to Müller's *Archiv* a monograph in which he carried the Schleiden-Schwann cell-theory into embryology, being among the earliest investigators to recognize the ovum as a single cell, and treating segmentation simply as normal cell division. Henle had discovered unstriated muscle in blood-vessel walls, but Kölliker was the first who succeeded in isolating it, and demonstrated that smooth muscle is composed of nucleated muscle-cells. In the seventeenth century, Leeuwenhoek described the spermatozoa, but it was left for Kölliker to explain their true development, and he again recalled Leeuwenhoek when he increased our knowledge of the branched muscle plates of the heart which had first been seen by the Delft microscopist.

Kölliker extended Corti's discoveries in the histology of the ear, and was the first to supply a satisfactory description of the fibrous layer of the substantia propria of the iris. Kölliker's proof that nerve-fibers are continuous with nerve-cells was sufficient to establish an immortal reputation, and it is perhaps in the minute anatomy of the brain and spinal cord that Kölliker accomplished his most valuable work: the neuroglia is known as Kölliker's reticulum, the ganglion-cells are spoken of as Kölliker's tract cells, and the gray matter surrounding the spinal canal is eponymized into Kölliker's nucleus. The journal of zoölogy which he edited for half a century, his treatise on comparative embryology, and his text-books on microscopic anatomy and human histology—the first comprehensive works on the subject—were replete with his unnumbered researches and discoveries.

It has truthfully been said of Kölliker—or von Kölliker, as he became in his age—that "there is no fragment of the body of man on which he did not leave his mark," and that "he knew more by direct personal observation of the microscopic structure of animals than any one else who has ever lived." He was one of the greatest histologists of all time, and one of the chief creators of its modern phase. With the exception of his prosectorship, and later professorship, in his native Zürich, Kölliker's academic life was passed in Würzburg. He was not lodged in the imposing palace whose walls took twenty years to complete, built for Bavarian bishops and grand-dukes in imitation of Versailles, but with the microscope which he brought to the archaic town Kölliker built temples of science where succeeding generations shall dwell.

The only time a professor feels really independent is when he receives a call from another university, and when Henle was invited to Tübingen it was a signal for another ultimatum, although on this occasion his demands were more on behalf of his colleagues than for his own department. Zürich, which had lost Schönlein, determined to keep Henle, and so prompt was its compliance with Henle's wishes, that he leaned back in satisfaction and wrote:

> I decide to remain. I would have to give up dear friends, a magnificent country, pleasant neighbors in Bern and Basel, and a brand-new anatomy, a large hospital, surplus of cadaver, good beer, an excellent servant, a prospect of numerous visits, leisure for work and much else.

Here was a profusion of reasons for remaining on Swiss soil, and yet Henle left unnamed the prime reason—Pfeufer. The friendship between these two men had grown until it could no longer be uprooted; socially and scientifically, the founders of the School of Rational Medicine were indispensable to each other. Pfeufer, the practitioner, could keep abreast of all anatomical and physiological researches by merely consulting Henle; and Henle the scientist, could undertake an elaborate treatise on general pathology without visiting a sick-bed, as long as he had the benefit of the clinical experience and diagnostic keenness of Pfeufer.

So Henle sent to Tübingen a letter of declination, and its ink had hardly dried when Pfeufer received a letter which caused fresh excitement—a call to Heidelberg; and the situation was further complicated when Tübingen answered that it would not consider Henle's refusal as final. Once more arguments were weighed and plans measured, and again they tried to read the secrets of the future, but mature deliberation simply served to bring the two friends back to their starting-point: the thought of separation was unthinkable: Henle said No to Tübingen, and Pfeufer said No to Heidelberg.

The students of Zürich expressed their gratification at the decision by a torchlight procession in joint celebration of the two professors. Leaning out of his window, Pfeufer thanked them for their speech, while the genial Henle descended to the street, and expressed his joy that he was in the midst of sympathetic colleagues and of students who were not merely concerned to acquire the superficial ability to practice, but desired to lay a scientific foundation underneath the superstructure of medicine. The flaming torches and the full-throated cheers replied with enthusiasm, and Henle and Pfeufer seemed destined to become the veterans of the Zürich faculty.

A few years previous, Henle had vainly scanned the academic horizon for a chair, but now alluring seats were offered him. Tiedemann, the ageing anatomist of Heidelberg, was anxious to secure Henle as his associate, but knowing that Henle would not stir without Pfeufer, it occurred to Tiedemann to bring Pfeufer along too. Together the friends were invited, together they accepted, and in 1844 they became members of the Heidelberg faculty.

V. ELISE EGLOFF

Confidential as was the relationship between these men, Pfeufer could not guess that Henle was motivated to leave Zürich at this time because there was a woman in the case. During a considerable portion of his Swiss sojourn, Henle lived in the house of his friend Loewig the chemist, in whose employ was a pretty nursemaid, named Elise Egloff. A man frequently imagines that a girl yearns for him when she only finds him ridiculous, and when a girl really loves him he is apt to overlook it—until someone tells him.

Henle had proposed marriage to several women who despised him for his meager pocket-book, and he did not see that Elise Egloff trembled with joy whenever she was permitted to serve him at table, and he could not know that when he played the piano or raised his voice in song, behind the closed door stood a woman listening with tears of passionate rapture. Elise guarded her emotions as carefully as she could, and Henle himself probably never would have stumbled upon the truth, but the girl's condition could not escape the vigilant eye of Frau Loewig.

One day she informed Henle that her maid was in love with him, and then impersonally called his attention to Elise's goodness and unusual beauty, never imagining that anything could ever bridge the social chasm which separated the young servant-girl from the great scientist. But as the man listened to the words of Frau Loewig, the heart within him leaped, and he was eager to begin an affair with Elise Egloff. Certainly he did not contemplate marriage, in fact, he could not explain what he expected, but his aroused instincts responded to sex-lure. Smilingly he entered into a light flirtation, but after the first careless step he could not retreat, for the fires of love blocked his path. In his graphic and matchless manner, Henle described the unexpected turn of events:

> My Lisette was a dear trusting Gretchen; I was learned and ripe enough for Faust, and bewitched enough. But Mephistopheles was missing, and there occurred the most ludicrous thing that could ever happen to a worldly cavalier in a relationship of this kind. I interested myself not only in the girl's beauty but also in her soul. I was won by her honesty, her kindness, her warmth and also her pride, which was doubly becoming to her because she felt her dependent position and bore it with resignation.

Since it is not considered proper for unwedded lovers to dwell under the same roof, Elise left the service of the Loewigs, and supported herself as a seamstress, and in this capacity still came occasionally to Frau Loewig. The intensity of her feelings caused her such deep suffering, that the alarmed Henle instituted himself her protector, and sought to deliver fatherly advice: he assured her that the most sensible thing she could do would be to forget him, and he pointed out that it would be best if she secured a position with a reliable family in some other town. So they agreed to part, but in spite of their repeated resolve never to meet again, their mutual passion swept them closer and closer together. The abyss that divided them was wide, and seemingly impassable, while the whirlpool of society's prejudice eddied underneath ready to engulf all who approached—but it was bridged by Elise's gentle hand. From the tender clasp, Henle could not withdraw, and in an illuminating passage he explains the situation:

> It was too late, and the gayly-made acquaintance now became a deep fountain of doubt for her and a great distress for me. For weeks I would avoid her; but when I saw her again, pale and thin, and I heard from the Loewigs how changed she was, and that they feared she was in a bad way, then I sought her out again and thought of nothing else but of consoling her and of trying to convince her to accept the untroubled present without thinking of the future. We had seen each other a few times again, when I received a letter from her friend, in which she implored me to leave Elise, and described her deplorable condition.
>
> I had never experienced anything so humiliating, or that shamed me so much, and I decided that things must change at any price. We agreed that she was to leave Zürich, and I advised her to go to the French Switzerland and later to take a position with a good family. A few days later, when I saw her again in the Botanical Garden—the place we had appointed for our rendezvous—she had upset all these plans: she could not leave Zürich; as long as she was able, a few times a week, to pass by my hearth and see the fire burning there, she would be happy.

In the meantime Henle received the call to Heidelberg, and out of his confused sensations arose one clear inspiration: Elise already possessed more charm and beauty than many a high-born dame; she was untaught but intelligent, and though she knew how to suffer, she loved life. Why not take this charming creature to Germany with him, and have her mingle with well-bred folks until she acquired the education and proprieties that would fit her to become Frau Professor? It was a hazardous experiment, but Henle felt that only in this way could he assure himself of a happy, or—if the experiment failed—at least, of an unreproachful future.

Henle was accustomed to solve physiological experiments by his own resources, but in this present problem, with its human entanglements and uncertainties, he turned helplessly to his sister Marie, announcing to her that he had a protégée in Traben for whom he felt a philanthropic interest. A portion of this statement was true, for in the spring of 1844, Henle had placed Elise in the little town on the Moselle to undergo her preliminary training before passing into Marie's hands, but he neglected to inform Marie that some day he intended to marry Elise. However, he confessed his secret to Marie's husband, Mathieu, and indeed it was his friendly brother-in-law who helped to locate Elise in Traben-on-the-Moselle, and rendered further aid by concocting a fantastic story regarding Elise's origin.

Henle knew Mathieu from the days when they were boys together in Coblenz, and Malchen Zeiller's rosy face seemed—to young Jacob—the sweetest thing in the world. Mathieu was interested in art to the extent of nailing classical prints upon his door, and after Henle explained this circumstance to Malchen and heard her comment, "That must be nice," he begged her to wait a few moments. He was a knight who lived only to gratify his lady's whims, and running at full speed to Mathieu's room, he lifted the door from its hinges, placed it upon his back, and carried it down the flights and across the streets—exhibiting masterpieces of Dürer and Holbein to passers-by—until breathless but triumphant, he showed the pictures to his beloved. Mathieu would have been incapable of such a feat, for he evaded the opposite sex so scrupulously that he was considered a woman-hater, but the sophisticated reader will understand that he was simply bashful. Whenever he visited Henle, he scrambled hastily up the steps in order to avoid meeting any of his friend's sisters, but it must be recorded that though Mathieu mounted the stairway three steps at a time, he evidently met Marie at the head of the stairs once in a while, for in the years that followed, when the gallant Henle was endeavoring to throw away his bachelorhood in three cities, the shy Mathieu was blissfully married to Henle's eldest sister.

Henle's second brother-in-law and intimate friend, the Hofrath Schoell, also knew of Henle's relationship to Miss Egloff, and after visiting the girl, related his impressions:

> She made an exceedingly favorable impression upon me. I found her very charming and was greatly moved. Then as it happens to everyone who stands face to face with her, I realized her peculiar position and I felt deep compassion for her. The thought that the situation may become extremely painful, if it should last much longer, troubled me. The fact that she was among strange people in a strange place, who had to remain strange to her, despite all their friendliness, because they were not permitted to know anything about her life, then the stress of her belated education, the change of conditions, the longing and secret passion, and the unknown future—all this is too much. If her lover had been of a less sentimental turn of mind, a more prosaic but for the girl a more practical way could have been found, which would have led to the same goal.

Apparently, Schoell did not know that Marie was not in the secret, for it was some chance words of his which first disclosed the actual state of affairs to Frau Mathieu. Naturally, she was indignant at the deception, and it is on record that she could not suppress the remark that she would have been far better pleased if her brother had revealed the truth to her before. But Henle managed to pacify her, and there was no interruption in their devotion to each other. That Henle did not belong to the international army of unappreciative brothers, may be seen by the following letter which he sent Marie concerning Elise:

I do not, of course, lay stress upon history, mythology, etc., but I wish that my protégée should acquire poise and deportment, which can come only through association with cultured people, and I wish her to learn to appreciate the finer shades of feeling and taste, which ennoble life. The school should merely round out the rough edges so as to make her capable of entering into select circles, where she can develop further.

In whom, but you, dear sister, can I place my hopes! You remember that I told you a long time ago, at a time when it did not sound like intentional flattery, that of all women I know, I should like to choose a wife who would resemble you in every respect. I was also convinced that you are capable of making sacrifices, great and small, in order to help me to reach happiness, which you know well how to value, and that you would be the last in the world to lose patience should the result not meet with expectations, and that you would be the first who would frankly, and free from prejudice, either approve of my decision or dissuade me, without any emotionalism, from the step I am about to take, depending entirely upon your judgment of your charge.

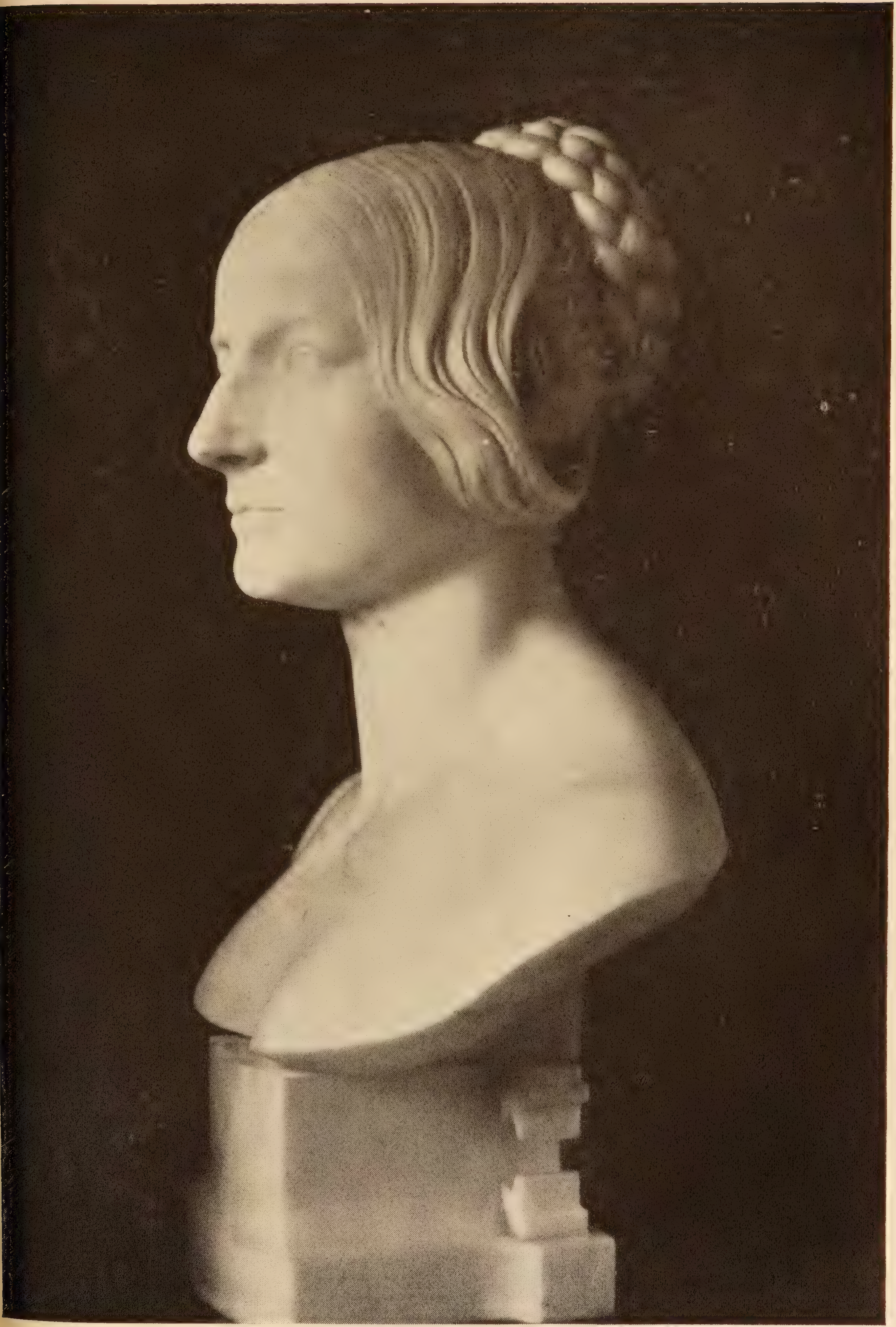
Marie now traveled to Traben to see Elise, and when these two women met, both were embarrassed. Later, Miss Egloff moved into Marie Mathieu's home, where everything possible was accomplished for her advancement. Herr Mathieu enthusiastically read to her the classic poets, while Frau Mathieu instructed her in the labyrinthine intricacies of social intercourse. Marie performed her duties faithfully, and her example was of inestimable advantage to Elise, but no one should be surprised to learn that Miss Egloff was more at ease with gentlemen like Mathieu and Schoell, who welcomed her cordially, than in the presence of Marie, who obviously could not help thinking that it was a trifle unreasonable for Miss Egloff to have fallen in love with her distinguished brother.

Since music was a necessity to Henle, a course of lessons in this branch was mapped out for Elise, but though she remained at the pianoforte with the assiduity of a child practicing for a much-desired reward, she made little progress.

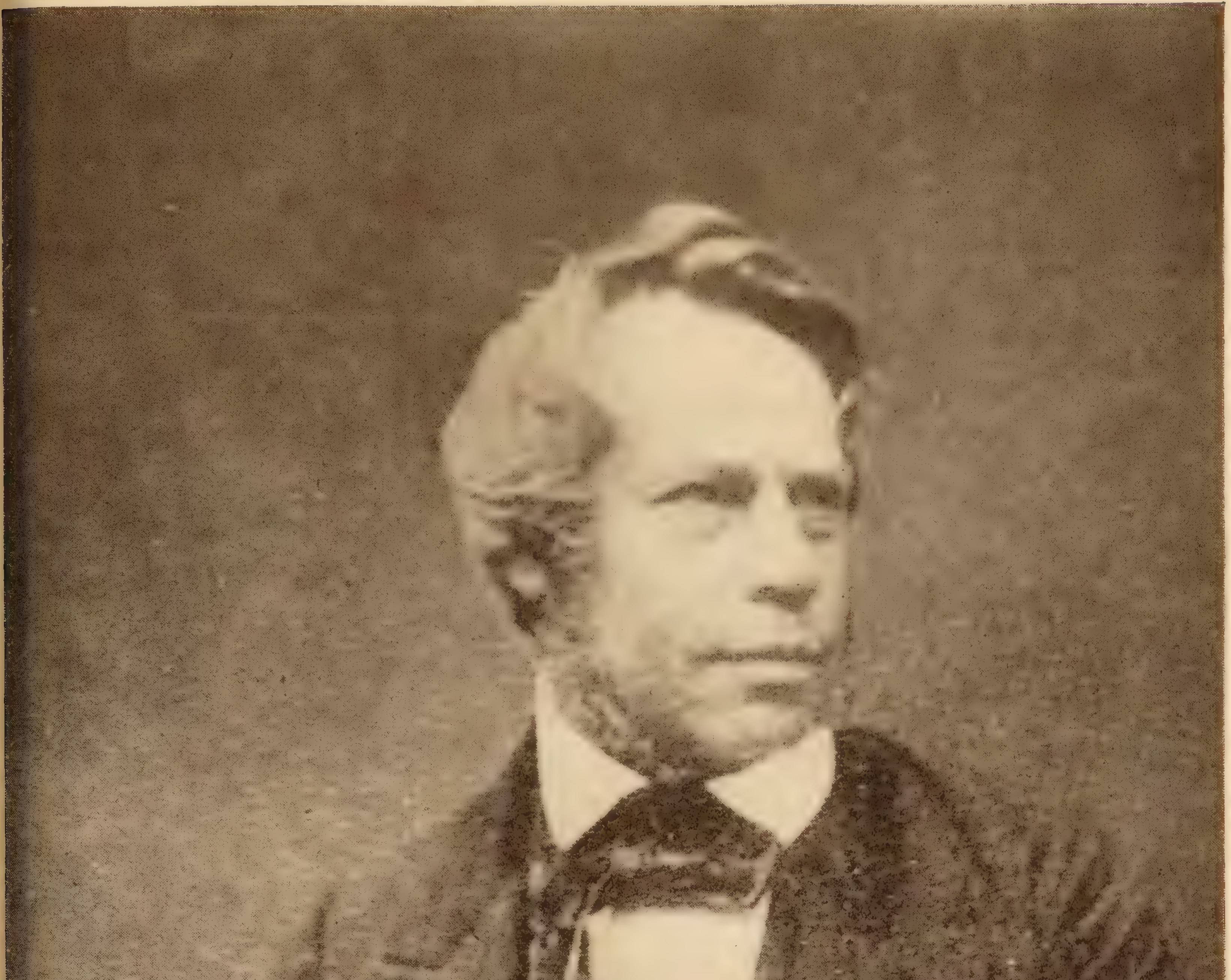
There was rhythm in her walk and music in her smile, but she could not master bars and scales. Aside from this failure, the experiment was such a brilliant success that within a short time Elise Egloff was transformed into a lady of the world who moved becomingly, amid general approbation, in circles bristling with cleverness and repartee, yet she made no breaks and she violated no commandment in the decalogue of etiquette. A certain moralist laid it down as an axiom that all women should act as seamstresses for their own families, but Elise did not discuss the art of needlework. The impoverished poet who was invited to the home of a lady of wealth, and began the conversation by asking his hostess if she had noticed the different colors of pawn-tickets, had no counterpart in Elise Egloff. Her feverishly acquired education, added to her native sense and delicacy, served to pilot her through society's breakers, and though there were dangers which threatened at times to wreck her peace, high above the foam gleamed the beacon of her faith in Jacob Henle.

Events now moved rapidly. In 1845, Henle asked his father's permission to marry, the betrothal was announced in the early months of 1846, and during the easter vacation Elise became Henle's wife. The honeymoon was spent in Vienna, where Henle was warmly greeted by the foremost medical men of the day, including Rokitansky, and especially by his friend who "spoke like Cicero and wrote like Heine"—the incomparable Hyrtl. In the celebrations and banquets that were accorded them, Henle noticed that not all the admiration was directed towards his learned self, but that a generous share was lavished upon his wife's charms.

On the return journey, the bridal couple passed through Weimar, where Elise attended the theater. The Grand Duke was one of the audience, but did not give his undivided attention to the play, for he looked long at young Elise, and finally sent his adjutant from his court-box to inquire who was the beautiful stranger who so fascinated him. And Henle, the ex-Burschenschafter, the dangerous demagogue who faced six



ELISE EGLOFF



HENLE

Photographed by C. Probst at Nürnberg.

years in a fortress because of his democratic principles, was overjoyed at this mark of royal favor. Perhaps he reasoned that if the Grand Duke knew nothing else, at least he knew a handsome woman when he saw her. The ladies of fashion who crowded around Elise, would have been either amazed or enraged to learn that two years ago she might have been their seamstress.

On reaching Heidelberg, Elise's defective education became evident, for she was forced to stand by while her husband fixed up their home according to a man's ideas, and the results were sometimes incongruous. Merkel admits that as a reformer in science, Henle was more successful than as a reformer of the household—he objected to curtains because they cut off some of the light. But in Henle's defense it may be urged that even if he did serve the roast on an earthenware platter, he bought the largest and most comfortable chairs and lounges obtainable.

Henle's most frequent guest, of course, was Pfeufer; one day when the clinician was visiting his friend's home, his eyes opened wide with alarm, for he heard Elise cough. An hemoptysis confirmed his suspicions, and Pfeufer diagnosed pulmonary disease. A period of rest improved her condition, and during the fall vacation Henle prepared to take his wife to Zürich. Henle loved company, managed to persuade sister Marie and brother-in-law Mathieu to come along, and made arrangements to meet Pfeufer on the way. It gave Henle pleasure to anticipate the look of wonder on the faces of the townspeople who had speculated over Elise's sudden disappearance, and would now find her a different being. But hardly had the merry pilgrims reached Zürich when Elise's malady awoke, and instead of a holiday companion, Pfeufer assumed his familiar rôle of physician.

As the days went on, repeated messages from Heidelberg called Pfeufer in consultation regarding some aristocratic personages, but he would not move from the sick-bed of Elise. It was due largely to his efforts that she returned home in such health that she was able, in the month of December, to undergo her first confinement without complications. The child was named Carl, and Henle reported: "Immediately he began to suck his thumb and to put out his tongue, from which I conclude that as far as his appetite and temperament are concerned, he will take after his father."

As Henle could not be content without frequent social gatherings, Elise arranged many parties and feasts for him. She proved to be one of those hostesses whose characteristics are a puzzle to men. Often she would get up in the morning pale and tired, and all day would be out of sorts and complain of depression, but as soon as the guests began to arrive, her features grew animated, beauty bloomed in her cheeks, and she radiated life. To entertain was easy for her, for she was the center of attraction.

It was a happy household, but tuberculosis draws a line from the home to Badenweiler. In the summer of 1847, Pfeufer ordered Elise to the famous health resort, but from its climate and springs she borrowed no relief. She returned to Heidelberg an invalid, and after several sad months gave premature birth to a daughter, named after herself. Then darkness settled over the house of Henle, and life and death waged their never-ending battle. The infant hovered between the two antagonists, and it became difficult for Henle to reach the bedside of his wife or child, for his old affliction assumed such aspects that the doctors debated whether amputation was indicated. During this critical period, Henle's sisters made splendid nurses, and Pfeufer was as efficient as an entire hospital staff.

As the days passed, the issue of the battle became apparent. Henle improved and was able to walk again, and baby Elise smiled at its first victory over death, but the lips of mother Elise were closed forever. Henle was inconsolable; for a long time he refused the distractions of society, and the sight of a woman was especially unnerving. He could not bring himself to visit the cemetery where Elise lay buried, and those who have read his private letters in which he bemoans the loss of so much grace, beauty and nobility of soul, say that their pathos is beyond words.

Her portrait was painted by Eduard Magnus—one of Henle's most important friends throughout the Berlin excitement—and the sculptor Meyer perpetuated her in marble. Berthold Auerbach, the distinguished novelist, was a daily visitor to Henle's shattered home, and later utilized Elise's life-story for one of his tales. Charlotte Birch-Pfeiffer, the famous actress and playwright, whose collected productions number twenty-six volumes, brought Elise upon the stage. Henle was deeply hurt at the manner in which these writers handled their theme, but the life of Elise Egloff was essentially dramatic: the secret passion and despair, wisdom captivated by beauty, the transformation from seamstress to hostess, the triumph followed by tragedy—these emotional situations could not escape the authors.

In her brief career she added a fragrant chapter to biography, for a sweeter figure than Elise Egloff never strayed across the annals of medical history—she is one of those who enriched the world with a romance it can never forget.

VI. PROFESSOR IN HEIDELBERG

The most vivid description of Henle in Heidelberg was drawn by a student who did not follow the Henlean path, but became one of the greatest clinicians of the century—Adolf Kussmaul. In his old age, recalling the memories of his youth, Kussmaul devoted a chapter to Henle from which we extract these picturesque passages:

> Henle's lecture was like a fresh, clear brook, upon whose lightly-stirring surface merry lights were playing. Although he framed his sentences in a simple manner, and retained his poise and calm, he was always entertaining, and his remarks, his humorous comparisons, and his sudden and unexpected flashes of thought, permitted of no ennui. When he said a witty thing, there was a smile upon

his lips, he touched the tip of his nose with his finger, and threw his head a little to one side, as though he wished to shake off this idea which escaped him while off his guard. Within a short time, the youthful professor won the favor of his audience. His academic and political past contributed to it that the students loved and honored him. A small sword-cut upon his left cheek reminded them that he had belonged to the Burschenschaft, and was therefore arrested and confined in the Hausvogtei. There, too, shone about his head the halo of a romantic love.

Henle's marriage with a charming girl from the lower classes—he, however, had his sister educate her—corresponded with the social tone of the time. It was the medical men who arrived at the conclusion that the anatomical equality of Eve's daughters should extend to social equality as well. Several of my acquaintances, and two honored professors of the faculty of medicine of Strassburg, stepped down from academic heights to take back with them untutored daughters of the people. A story reached me, in the spring of 1847, how a Heidelberg teacher and anatomist, a pupil of Henle, was given his congé by a pretty child of the merry Pfalz. He wished to follow his adored master not only in the study of medicine, but in the choice of a wife as well. His young, fresh waitress appealed to him, and he made her a proposal of marriage with the proviso that she should first be educated in a private ladies' school at his expense, so as to be fitted for the position which she was to occupy as his wife. But he fared badly. She flared up and demanded to know whether he was in his right senses; she told him she already had a sweetheart for whom she was well enough educated; a trim butcher, who outweighed two such lean doctors.

In the forties, science had not secured its divorce from superstition, for their union was upheld by many professors who were better versed in piety than in pathology. The name of Obermedizinalrat Ringseis means little to the present generation, but in his day he was a power in Germany; the filling of numerous posts depended upon his judgment, and this man firmly believed that disease was due to sinning against God and could be cured only by the grace of the church. Moreover, a host of system-spinners performed no experiments, but built up fanciful little cults into which they attempted to fit the science of medicine. Across these winding mazes—beginning in involved hypotheses, and ending in an interminable network of classifications and sub-divisions—Henle cut a bold new road, and the academic youth of Germany followed the pathfinder. They swarmed to his lectures, and the venerable members of the faculty found themselves neglected for the new favorite. Shortly after Henle's arrival in Heidelberg, an incident occurred which brought back the Zürich period. The night grew alive with light, and music blended with the upraised torches and then a student stepped forward and spoke:

> We are assembled here this evening, that we may show a slight mark of our appreciation of one whom we esteem as a thinker and research-worker, whom we admire as a teacher, and whom we love as a man. As a discoverer, he struggles untiringly and indefatigably at the head of those who oppose the wretched empiricism of medicine. The frost which had covered our science has been broken by his efforts, and already the tree bears spring-blossoms for the cure of suffering humanity.
>
> With pride, the German nation points to the astronomer Kepler, who through telescopic research guided us into the immeasurable starry infinite, and so has our teacher's microscopic research opened to us the organic infinite. We admire him I say, as a teacher, for he has presented to us the truth, simply and convincingly, free from the nimbus of exaggerated erudition. I repeat, we love him as a human being, for science did not extinguish in him the desire for the well-being of mankind and for the fatherland. From a full heart, let us call a thousand-voiced Hoch to this honored man.

Henle's answer, which was hailed with loud rejoicing, was simple and inspiring—a model of what such replies should be:

> Gentlemen, I accept this unexpected mark of your appreciation with thankfulness and pride. I shall not say, as is so often done, that this honor is impersonal. I say, this is done to me personally. But what may be the reason for this appreciation? I believe it is

> nothing else but that I am one of you. Much rubbish is at hand, which we have to clear away. With united forces, we are endeavoring to do this. We are commilitants—truly a wonderful name. Comrades-in-arms are we, in the campaign in which we are going to make new discoveries. Let us call a Hoch to the camaraderie of our science and to our university.

The significance of this ovation lay in its spontaneity, for it was not Henle's birthday nor the anniversary of anything, and the whole celebration was the instinctive tribute of youth to a new leader. The Easter of 1845 witnessed an even stranger event: Henle utilized this vacation to call upon his publisher in Braunschweig, and upon his return, visited Leipzig, where Felix Mendelssohn invited him to dinner and music; next he turned toward Halle, where he had an appointment with some scientific friends, and let Henle relate what happened at Halle:

> On the second evening, I was surprised by a serenade by a deputation of medical students; one of them made a beautiful speech and they cheered me, to which I replied from the window with the calm and self-possession of a man quite accustomed to such occurrences. The speaker said among other things that fault had been found with the medical men of Halle for following practice to the exclusion of theory—but they simply kept at a distance from the poor theories of the past. Now, however, that I constructed a new basis, founded upon physiology, they were just as zealous as any one to follow this path, etc., etc. My reply was not exactly beautiful, still it was fluent. I was somewhat embarrassed as Halle's professors were standing by, and had to witness this boosting of a stranger.

How frantically some men have worked to become a Hofrath, how ceaselessly they have schemed for it—and how easily it is thrust upon others who never coveted the aulic counselorship. When the Government of Baden conferred this distinction upon Henle and Pfeufer, the former wrote to his father:

You know what I think about this. I am not exactly overjoyed that I shall no longer hear my beautiful and well-earned Professor's title; under the present condition, however, and as we did not behave very tamely to the administration and did not take one single step to reach this honor, and as hardly a year has elapsed since our appointment, we have to acknowledge it a mark of recognition, which promises a certain influence for the future, and this is in no way desirable to our cringing colleagues. My chief regret is that I have no longer any right to tease Schoell. I spent a few enjoyable days in Halle, and was received by the students with a serenade there, which gave me more pleasure than the so-called favor of the lordships.

The year of destiny, 1848, opened inauspiciously for Henle. His Elise lay on her death-bed, and on the twenty-first of February, death took her. Quiet had come to her, but the world was in revolution, and Heidelberg was the center of the cauldron. From the public turmoil which naturally agitated Henle, he could not escape to a home of peace and comfort; after the day's labor, no hearth awaited him where he could throw off his cares with his overcoat—eventful 1848 was the unhappiest year of his life.

As the weary months wore on, his sister Helene determined to come to his rescue. She had a friend named Marie Richter, the daughter of a Prussian army officer, and eloquently she sang Jacob's praises to Fräulein Marie. Fourteen months after his wife's decease, Henle visited his father and sister Helene at Coblenz, and there he met not only his relatives but was guided to the vicinity of Miss Richter—while Helene watched and waited. Her patience was not severely tried, for Helene's brother and Helene's choice fell in love with each other at once. Within a few days, the scientist proposed, and was eagerly accepted. Frau Mathieu now visited the girl and the letter of sister Marie is full of praise for sweetheart Marie, but it reveals also the writer's own nobility:

As far as human insight goes, we can be pleased over this union, for Marie Richter possesses all the qualities from which we can expect that she will adorn the family hearth, and from the very first meeting with our brother she seemed to have become heartily attached to him, and affection is to him a life's necessity. She is a charming, well-appearing girl, and will, according to all indications, be a good mother to his children.

Unlike poor Elise, Marie Richter was proficient in music. After an engagement of a few months, Henle and Marie were married, and they made the fairy-tale come true by living happily ever after. In due time, a merry daughter, Anna, was born to them, and she was followed by little Sophie. With children and honors and the pages of his Handbook of Rational Pathology periodically increasing, Henle seemed rooted to Heidelberg. Contentment reigned at his fireside, but with his colleagues he was at constant war. When Henle was a Heidelberg student, Chelius, Tiedemann, Naegele and Puchelt were of the faculty: years later, on returning to Heidelberg as professor, Henle found the faculty unchanged. Science had marched on, but Tiedemann, Puchelt, the stately Chelius, and their confrères, still sat in their well-worn chairs—untouched by the new era. Upon their doors the young generation knocked loudly, for the modern Dioscuri—as Henle and Pfeufer were called—had valiant hands. Henle's opinion of his venerable colleagues may be plainly seen in the following letter, brief but bristling with invective:

> I am still somewhat strange here, and hope to remain so unless new elements appear. To feel at home among these boresome antique university-pigtails, would, as Pfeufer and I tell each other, be for us a degradation. Here nothing remains but to allow the old to die out, and to found a new colony. Both the government and the students seem to wish to help us as much as possible. The government, whose eyes have now been opened, is astonished how the faculty utilizes Heidelberg's reputation and its wonderful location, to fatten in comfortable calm and lock themselves in from intruders. Everything except the residences, country houses and vineyards belonging to the old gentlemen, is in a wretched condition. But the students are already beginning to see that something

new, something capable of development, is offered them. They are full of enthusiasm for our rational medicine, and consequently enraged at the backwardness of affairs here.

Even Henle's friends have blamed him for the bitterness here displayed, but whether justifiable or not, the letter expresses Henle's attitude—and it did not soften with the passing years. The hostile relationship between the Henle-Pfeufer group and the elder members was further strained by a powerful series of unsigned articles in the recently-founded *Deutsche Zeitung,* praising the progressive elements in the university, such as Henle, Pfeufer, Vangerow, Jolly and Rau, and lashing the "reactionary periwigs." But though these articles were anonymous they were not the production of a nameless journalist, but of Georg Gottfried Gervinus. He was one of the famous seven who left the university of Göttingen when the king of Hanover tore up the constitution, and he became professor of history at Heidelberg in the same year that Henle was appointed professor of anatomy. Gervinus wrote the first satisfactory History of German Literature, and after a venture in practical politics—from which he soon retired in disgust—he devoted his time to the thesis that his favorite poet, Shakespeare, and his favorite musician, Handel, were very much alike intellectually, because of their common Teutonic origin.

As already indicated, it was the anatomist Tiedemann who had opened the gates of Heidelberg to Henle, but after their first personal contact, the elder man took no pride in his protégé, and the younger felt he owed the other no gratitude. They represented different viewpoints, and between them there could be no sympathy. Oddly enough, it was a question of architecture that fanned Tiedemann's smoldering animosity into a wild paroxysm. The new Anatomical Institute was then nearing completion, and as its nominal director, Tiedemann gave certain orders for the furnishing of its interior —during the absence of his associate. Henle was an indefatigable worker, but he was so human that he went off on a vacation every time he had a holiday; upon his return, he criticized Tiedemann's plans, and was especially displeased with the arrangement of the auditorium, which he pronounced unserviceable. When leading architects confirmed Henle's statements, old Tiedemann's anger was uncontrollable: not only did he accuse Henle of a dastardly lie, but he shouted that his young colleague was a shameless Jew.

Tiedemann's shriek reached farther than he expected, for Zürich heard that Henle had resigned, and cordially offered him his chair again. Henle was undecided whether to accept, and it is interesting to note that at this period he was so adrift that he even contemplated emigration to America. But Heidelberg would not let Henle go: the ministry rebuked Tiedemann for his insult, demanded that he apologize in writing, and conveyed a hint to Henle that the director would soon retire. Henle's friends, such as Pfeufer, Gervinus, Vangerow and Jolly, thereupon met in supreme council, and having decided that his honor had been sufficiently vindicated, they induced him to remain.

Fate practised its cruelest tricks upon Tiedemann's declining years; his adored son was one of the revolutionists of 1848, and when the wonderful year was dead and retrogression again assumed its ancient throne, the young man was court-martialed and shot. Then the old professor resigned from the university where he had become a tradition, and at last Henle's heart went out in sympathy toward his fallen antagonist.

But the same forces which murdered young Tiedemann, eventually drove Henle from the faculty. During the fifties, darkness held its carnival at Heidelberg, dispersing the liberal circles that had gathered there. For publishing an essay which was to serve as an introduction to his History of the Nineteenth Century, Gervinus was placed on trial for high treason. The proud man disdained to defend himself except to say, "This charge, though it appears directed against me, is really an accusation against History, which cannot be condemned." But the reactionary government of Baden was not afraid of

History: it burnt Gervinus' pamphlet, and sentenced the writer to four months in prison.

When Heidelberg had become impossible, Pfeufer and Jolly accepted Munich's welcome invitation, and Henle responded to the call from Göttingen. After twelve years of constant association, Henle and Pfeufer were to part. "That we do not go together," wrote Henle to his sister, "pains us both, but I think I may say that our friendship has reached its zenith, and it is better that it should be forcibly rent asunder than that it should cool off." Even when moving day came, Henle did not experience the usual sadness of farewell, and his first Heidelberg letter was rounded out by his last:

> I depart, for the second time from a wonderful country, with the regret that it is not peopled with better men, and I shall gladly take in its stead some sand and meadows in order to be able to live among scientific colleagues and under a government to whom one does not become objectionable because of one's justified ambition for one's institution.

So the scientist left the wooded banks of the Neckar and turned to the North, but the stormy Heidelberg years were not barren, for Jacob Henle carried with him to Göttingen the completed copy of his great Handbook of Rational Pathology.

VII. THE CALL TO GÖTTINGEN

In the anatomical building of Göttingen's university—"the great university in the small town"—old Rudolf Wagner, conspicuous for his religious zeal and remembered for his discovery of the germinal spot, awaited the coming of Jacob Henle. Professor Wagner had feared this day, and long fought against it; it was his heart's desire to die teaching anatomy, but as his years advanced and his health declined, both colleagues and students insinuated, gently at first and later with increasing pressure, that he step aside; he prepared to withstand all his opponents, but a hemorrhage came to their aid, and the pious man humbly said, "Now that the living God has spoken, I must bow my head,"—and in submission he sent for Henle. After Wagner and Henle met, the latter, with his usual perspicacity, explained: "My position towards Wagner is similar to that I once held in relation to Tiedemann, with all its difficulties, except that Wagner is a much finer character, and fundamentally a good man. But it is asking too much that he stand by, and see how someone inherits from him, while he is still alive."

The halo of spirituality which shone about Wagner, received a few crimps from Karl Vogt, but it shed its beams upon Henle, who was accordingly granted an interview with George v., the sightless king of Hanover. In those days, many letters passed between Göttingen and Munich, and Henle wrote to Pfeufer:

> I have had the honor of dining with his Majesty at Rotenkirchen. This is not so remarkable that you should be informed of it, but that this honor is due to my piety, will surely amuse you. The king received me with the statement that he felt it a necessity to inform me how much he congratulated himself upon the acquisition of a teacher whose reputation as a scientist was combined with that of a strictly Christian mind. The poor deluded man had, on his way through Heidelberg, received a visit from colleague Wagner, and apparently had some specific conversation with him, and then, because of my matter then pending in Heidelberg, he somehow connected me with this visit, and so I stood face to face with him as a brother in Christ in talar and a white neck-tie, in which you once, in your friendly partiality for my exterior, compared me with calf's head *en tortue,* and with a countenance which must have appeared still more strange, as my heroic efforts to set it into strict composure were lost upon the blind king and the entire work was done merely for the love of God.
>
> I did not have the heart to spoil the king's joy, for he cannot get rid of me now; and when he began to reason about deists, I was able to assure him without hypocrisy, that I too did not believe much in deism, and when he expressed the conviction that a professor of anatomy could, in his lectures, do much for the propa-

gation of religious faith, I made him very happy when I remarked that I always call my hearers' attention to the defects of human understanding, even in tangible things. If I talked a Guelfenorder on my neck or into my button-hole, you may rest assured that I shall put it on with a blush. His majesty immediately grasped the opportunity of informing himself regarding the utility of the blind gut, and we had arrived in this remarkable private audience as far as tapeworms, when the Hofmarschall announced that the soup was served.

In the fifties, pastorals could have been bred in Göttingen, for rusticity was its keynote. The same sylvan paths served for professors engrossed in meditation, and for cows intent on rumination. There was no railroad nor thriving industries, but every family kept a pig-pen whose dwellers spread the fame of Göttingen sausage. It is true, the principal streets of the town were lined with paving stones, but between their crevices the grass grew with sufficient luxuriance to satisfy herds of sheep. On his initial contact with this ruralness, Henle was appalled—it seemed incredible, after his active career, that he should pass the remainder of his days amid such provincial surroundings. As soon as he heard that Pfeufer was negotiating for him at Munich, Henle left his home half-furnished and wrote to his friend:

> I would much rather use my energies in connection with yours, to build up Munich's university than work here in this retirement, for the preservation of a university which blinks melancholically backward upon the good old days. I long for the merriment of the South and the animated life of a large city, more so for the sake of my wife and my growing progeny than for myself, for I, at least, have beautiful memories to live upon.

Gradually the peace of the small town enveloped the spirit of Henle, and Pfeufer learnt that his Göttingen comrade began to lecture on special anatomy, "in that melancholic-trembling voice which you know so well," and the following bucolic was transmitted to Munich:

I find myself in the cleanest and richest of anatomical professorships imaginable. To use the classroom expression, I am "surrounded by all the integral stimuli" which a man and a professor requires in life—only the vexatious and the exciting ones are lacking. We have time, money, devout pupils, and complete teaching apparatus. The colleagues are nothing but open encyclopedias. All are as virtuous and as industrious as I hope to become, because there is no opportunity for anything else.

The city lodges many students and their teachers; it also harbors the necessary bootblack, a cobbler, a tailor, an inn-keeper, and a burgomaster and four gendarmes who govern these citizens. At the stroke of the hour when the lecture is over, it is somewhat livelier in the streets; at twelve it is noisy, because besides the home-returning men, the streets swarm with maid-servants with baskets filled with berries and prunes. Carriage wheels are heard only when there is a ball, or when a professor is being buried. At four o'clock everything rushes on the Wall, and runs once or twice around the town, after the fashion of hemorrhoids, more or less completely blind.

I have already found a student who plays the violin; as I wished to form a trio and needed a C string for my violoncello, I inquired at the store and found that the store-keeper permitted the article to run out, because for two years there had been no demand for it. She would, however, have one spun for me. When it was ready, I had to have the opening in the tail-piece of my instrument made larger, because the string would not go through.

In public and social life, much has been retained to remind one of the town's former connection with England. There is much more civic freedom here than anywhere else in Germany; restrictions of hats, books, collections, etc., would be just as impossible here as in England. We know nothing of either the religious or political faith of our neighbors. But aside from independence in vital matters, there is to be found the English sameness in non-essentials; the unalterable roast at dinner and a certain stability in food and drink, which in spite of the hospitality of the host and the merriment of the guest, would bring people of your sensitive taste to despair. Every Sunday we meet the same *valet de place,* who tells us in advance where we shall dine together the forthcoming Sunday, and everywhere are to be found the culinary products of the same cook.

Henle sealed his contentment with Göttingen by buying a home, situated directly on the promenade which led around the town, shaded by magnificent lindens, and enriched with a garden of rare plants and old trees. The house had formerly been Langenbeck's private hospital, and the walls which once saw the master surgeon amputate a shoulder while you took a pinch of snuff, now witnessed happier scenes. If an academy, a library, an opera and a dramatic troupe had arrived in Göttingen, all at once, they could not have aroused the town more than did Henle's advent. He formed his colleagues into a Friday Night Club, and was its animating spirit, but intercommunion with fellow professors never sufficed for Henle; gathering groups of students and young privat docents around him, Henle organized musical and theatrical circles. His home became the headquarters of visiting artists, and his position as director of the museum enabled him to utilize the museum's hall for concerts. Renowned men and women participated in Henle's musical evenings: here were heard Joachim's violin, and the mezzo soprano of Amalie Weiss.

Among Henle's new professional friends was the dermatologist, Conrad Heinrich Fuchs. "I begin to feel," wrote Henle to Pfeufer, "a great attachment to Fuchs, because of the pleasant recollections which his doubtful hard 'b' awakens in me, and also for his kind nature and modest manner, in which there is nothing to remind one of the pretentious System of Skin Diseases." The point of this note is that Pfeufer and Fuchs were natives of Bamberg, and therefore found it difficult to pronounce the alphabet's second letter; moreover, Fuchs was an adherent of the so-called Natural History School, and he proved it in his once-famous book on diseases of the skin, for while it contains many valuable observations on etiology and diagnosis, and even on therapeutics, the effect is marred by its incomprehensible nosological arrangement. Had

Fuchs not made the slightest attempt at classification, instead of devoting his chief energies to it, the result would have been less bewildering.

Another friend was the obstetrician, Eduard Caspar Siebold, a member of what Lorenz Oken called the "Asclepiad family of Siebolds." He is now remembered for his classical history of midwifery. Siebold was a singer, and played the kettle-drum and tymbals with unusual skill—and Henle did not permit him to neglect these instruments. Henle asserted that at the very first tone, he could tell whether Siebold or an ordinary drummer was playing.

Then there was Friedrich Wöhler, who was certainly worth knowing. He graduated in medicine and surgery at Heidelberg, and intended to become a practitioner, but he had already worked in the laboratory of Leopold Gmelin, and was persuaded by him to devote his life to chemistry. Gmelin discovered potassium ferricyanide but Wöhler may be regarded as Gmelin's chief contribution to science. The young Wöhler went to Stockholm to study under the great Berzelius, and in later years, along with original researches, he translated his teacher's work from the Swedish. His friendship with Berzelius was matched by his lifelong relationship with Liebig, with whom he was associated in many important researches. Wöhler taught for brief periods in Berlin and in Cassel, but for almost half a century he held the chair of chemistry in the medical faculty at Göttingen. Wöhler was the man who broke down the barrier between organic and inorganic chemistry by constructing an organic substance out of its inorganic constituents—and thus the vital force theory received its death-blow. It was granted to Wöhler to make another discovery of permanent importance: just as his synthesis of urea marked the beginning of modern organic chemistry, so his demonstration that benzoic acid taken into the body reappears in the urine as hippuric acid, opened the modern era of the chemistry of metabolism. Wöhler was equally interested in analysis and among the elements he isolated were aluminium, beryllium and yttrium.

Felix Droysen fec.

HENLE IN THE CLASS-ROOM

Drawn in 1877 by the student Felix Droysen, showing the teacher's eloquent back.

In the spring of 1858, the sons of science went into mourning, for the father of scientific medicine in Germany bade them the last farewell. No longer would his voice be heard in the lecture-room, nor his guiding hand felt in the laboratory. His pupils remained—Schwann was at Liége, Henle at Göttingen, Kölliker at Würzburg, Brücke and Ludwig at Vienna, Wilhelm His at Basel, Virchow at Berlin—but their teacher had left them. Johannes Müller was dead, but the work must go on, and mighty Berlin turned its eyes towards the town of Göttingen, where now dwelt Germany's greatest anatomist, Jacob Henle. The times had changed, for the city which had thrust the youth into prison, invited the man to enter its university as Johannes Müller's successor. When Pfeufer read in the newspapers that Henle had received the offer from Berlin, his emotions were on edge, and he immediately wrote to Henle asking him if he intended to accept, and assuring him that though he might conclude his life with more contentment in Göttingen, yet it was certain that he belonged in Berlin. Without delay, Henle replied to his most intimate friend:

> It is true I received an offer from Berlin, as brilliant as possible, purely for anatomy, with a to-be-newly-constructed building, with a prosector of my own choice, with a seat in the faculty and at the state examinations—and I have rejected it. Not without a great mental struggle; but on what solid basis my final decision was founded was proven to me when I read your letter, which in spite of the fact that I have always valued you as an authority in practical matters, could not shake my peace of mind. How much I would have liked to have gone for advice to my old friend! The matter was left entirely to me, as not even my wife would give a sign of what preference she felt, and the Berlin Geheimrath, who unexpectedly crashed in on me with this offer like a bomb, insisted on coming back for my answer on the following day, and could only be persuaded to depart when I gave him my assurance that I would forward my decision within forty-eight hours.
>
> You may voice your objections that I permitted myself to be so hurried. I however, wished that the Prussians should not lose more

time than necessary, as I felt from the outset that their efforts to get me would be unsuccessful. I am greatly attached to Göttingen; I felt at home here from the first moment; every change that has occurred has made my position more comfortable; and I can surely count upon it that it will be the same in the future, and that in any matter concerning the university I shall have a decisive voice. I contemplated Müller's position without the slightest envy, while he, on the other hand, called my position a more enviable one. Why should then, the accident of his untimely death give me an incentive to see if I could not have things better than I already have them?

The great city and its manifold contacts do not possess the same attraction for me as they do for you; it is probably the result of my provincial origin that the bustle of strange and stiff people makes an unpleasant impression upon me, and that I find more comfort in the quietude in which our life flows on here, under the shadow of our trees and among a few everyday friends. Besides, you must not draw a parallel between Berlin and Munich, and between Göttingen and any other small town. For Munich has, besides all the agreeableness of a large city, still many congenial rural elements, which Berlin lacks, and Göttingen is more a country seat for a number of professors and students than a small town. If we gradually appropriate *das Geschmaeckle* of which you speak, we do not notice it upon each other, and if it is apparent to our friends from large cities, whom we unfortunately meet but seldom and but for a few days we must hope that they like us well enough to put up with it.

If I felt some of that self-confidence, with which I would have gone into Parliament in 1848, if my leg had permitted me to stand up at the time, I would consider it my duty to become the citizen of a state, which after all, is the dominant factor in German affairs. But I have not yet forgotten, how at the time, it was not my wit, but merely my misfortune, that saved me from compromising myself. That I can bring up my children here physically stronger and mentally less blasé than would be the case in Berlin, I know for certain. And for me the reflection over going or remaining was merely a struggle between inclination and duty. Whether it was right for me to withdraw myself from such an important and influential post, with great resources, and not participate in the list of a tournament to which I was called, I shall have to justify myself before my conscience and my friends whose eyes are focussed upon me.

How alone I would have stood! Was it not characteristic that not the slightest hint, not a friendly word of persuasion from the lap of the faculty, or from other friends, preceded the arrival of the Berlin mediator? Could I be indifferent to the fact that since leaving Berlin, I received not the slightest mark of distinction from the medical societies that spring up there, and that the Berlin Academy purposely avoids me? Though I am not in the habit of imagining things, still it seemed to me quite clear that I made myself unavoidable through my book, and that I was proposed and expected as the inevitable one. And Fr. who was supposed to have dished out the gravy, belongs to those who will not forgive me because I did not wait for the physicians to clean out the pathological stall. . . .

Could I, without flattering myself, hope to exercise influence upon the course of studies in Prussia? Dear friend, we both know that we, with united forces and in younger and more spirited years, were unsuccessful with the subdual of a less tough dough. A man of Müller's importance had difficulty enough, and had to often play his highest trump to remain unattacked in his own field. This is, and we have often acknowledged it, not my terrain, and a man of fifty years should not deceive himself into imagining that through transplantation into a new soil, he can acquire new qualities. I live chiefly to please myself, and believe myself to be useful to others if I give to the world the results of my quiet musing.

To satisfy this passion, there is no place more suitable than Göttingen. Were I to go to Berlin, I would have interrupted my work for a few years, first because of the removal and then because of the work incidental to the building up of a new collection. How terribly Müller had often sighed over the burden of the state examinations, which took up, year in and year out, so much of his time. Forgive this long exposition. But as you do not know either Göttingen or Berlin in their modern phases, the matter could not be explained briefly. Verbally, I could even say much more. Could you but glance into our activities! You would not wish to live here, but you would understand why others feel themselves so attached.

Until he came to Göttingen, Henle was a peripatetic: six years he was Müller's prosector in Berlin, four years professor in Zürich, and for eight years professor in Heidelberg—but for the remaining thirty-three years of his life he was settled. It was Reichert who went to Berlin as Müller's anatomical heir. Henle remained in Göttingen, cultivated his garden, paid the mortgage on his house, and worked on his masterpiece, The Handbook of Systematic Anatomy.

VIII. THE JUBILEE

In 1866—a year famous for its quarrels—Bismarck and King George could not agree, and Bismarck characteristically ended the argument by annexing Hanover. By this act of absorption, the University of Göttingen ceased to stand apart in cloister-like aloofness, for its faculty automatically became members of the University Society of Prussia. Henle had refused to come to Prussia, but Prussia had come to Henle.

The new state of affairs divided Hanover into those who favored the annexation, and those who disapproved, and in the factional disputes that naturally followed, many old friendships were broken. Henle was at all times opposed to Bismarck's internal policy, and bitterly resented the statesman's present tactics, and therefore five professors resigned from his Friday club. For some time to come, at the least provocation, Göttingen was split into Prussians and Hanoverians; for example, in 1868, Henle's son Karl arranged a ball at the museum, and a sleigh-party comprised of students and young ladies. They rode out into a storm that traveled straight to the door of father Henle, who thus explained the cause of the tempest:

> The sleighing party which took place a few weeks ago and the dance that followed, resulted in a complaint of the police-director to the pro-rector, wherein he summed up the sleighing party under the heading of "gathering under free skies," for which the police is to grant permission forty-eight hours in advance. It required much paper to convince the bone-headed bureaucrats that

> you could not order snow to remain on the ground for forty-eight hours.
>
> Another and much worse excitement, which extended even to the lowest strata of society, and which once more divided the city into Prussians and Hanoverians, was the ball arranged in the Museum by Karl and his friends. It required a general meeting of 120 earnest men to decide in a conference, whether there is a difference between a feast and a ball, and whether the feast could only be arranged by private individuals and the ball only by the director. To speak more correctly, they merely seemed to hold this conference, for its actual purpose was the official assassination of the present director. I shall, therefore, like Bismarck, be more constitutional than is expected, and shall resign the post which for seven years deprived me of much time, and during the past two years caused me much aggravation, and was only of value to me in so far as I had the disposal of the hall at my command, and was able to invite artists here and keep in touch with them.

Henle sought relief from these agitations by an excursion to Upper Bavaria. Tourists who visited the Tegernsee during the fall of 1869, were apt to come across a quintet whose hair was gray, but who chatted together with all the abandon of youth. Many years had passed since the dissolution of the Heidelberg circle, but now Henle, Pfeufer, Jolly, Gervinus and the orientalist Hitzig were together again, reveling in the beauty of the mountain-lake and in the luxury of old memories. Towards the end of the vacation, when Henle and Pfeufer clasped hands with the love of thirty years between them, they promised each other to meet again next year; three days later, word was brought to Henle, that Pfeufer, while journeying to the Achensee with his wife and daughter, dropped dead in the boat. Henle wrote to his sister:

> Those were three wonderful weeks which I spent with my old friend. Never since we left Heidelberg to go in different directions, did we associate with each other so long and so uninterruptedly. Although the lake lay between our residences, we were together every day and usually twice a day. In the morning I had myself

rowed over, and at noon his daughter rowed me back in a boat which she had hired. In the afternoon, we generally met together with our retinues on some beautiful spot whereto we went on foot, and Pfeufer in his carriage. Then I had to sit at his side while his grandchildren and my children played around us, and from time to time he would send me away to talk to his wife, who found it painful when she did not hear me.

We spoke of everything—our science, our politics, our families; it seemed as though I was to carry with me the conviction that we were of one mind in everything. He suffered somewhat from asthma, was more sluggish in his movements than before, tired easier, but mentally was as fresh and alive as ever. He did not think of any danger; his concern was chiefly that he would become too weak for his teaching activities, as the clinic exhausted him and the crowds of hearers in the hospital rooms oppressed him. He contemplated giving up the clinic. He still felt strong enough for lectures and for his office. We parted with the understanding to meet again next fall in a different place, for though we found Tegernsee charming, we had already drained its beauties.

Three days later, he was dead. His death was such as he wished for himself and for me, for he said this in a letter which he wrote to me after our father's death. We cannot bemoan his fate; the autopsy showed that he had been approaching an unforeboded serious affliction. But the situation of the wife and daughter who returned from a trip so joyously undertaken, with the corpse at the bottom of the boat! We received the sad news in Munich at the art exhibition. The distraction of the return journey, the life in the overfilled family house in Nürnberg, the pleasure in seeing the sisters in Mainz in good health, helped me to bear the first pangs of the grief. Now when I find myself in the old familiar rooms, I first feel how much the absent friend was tied up with all my doing and thinking.

Henle kept a bust of the departed upon his desk, and Merkel says that many a hallowed glance fell upon it. Henle wrote to Pfeufer's widow:

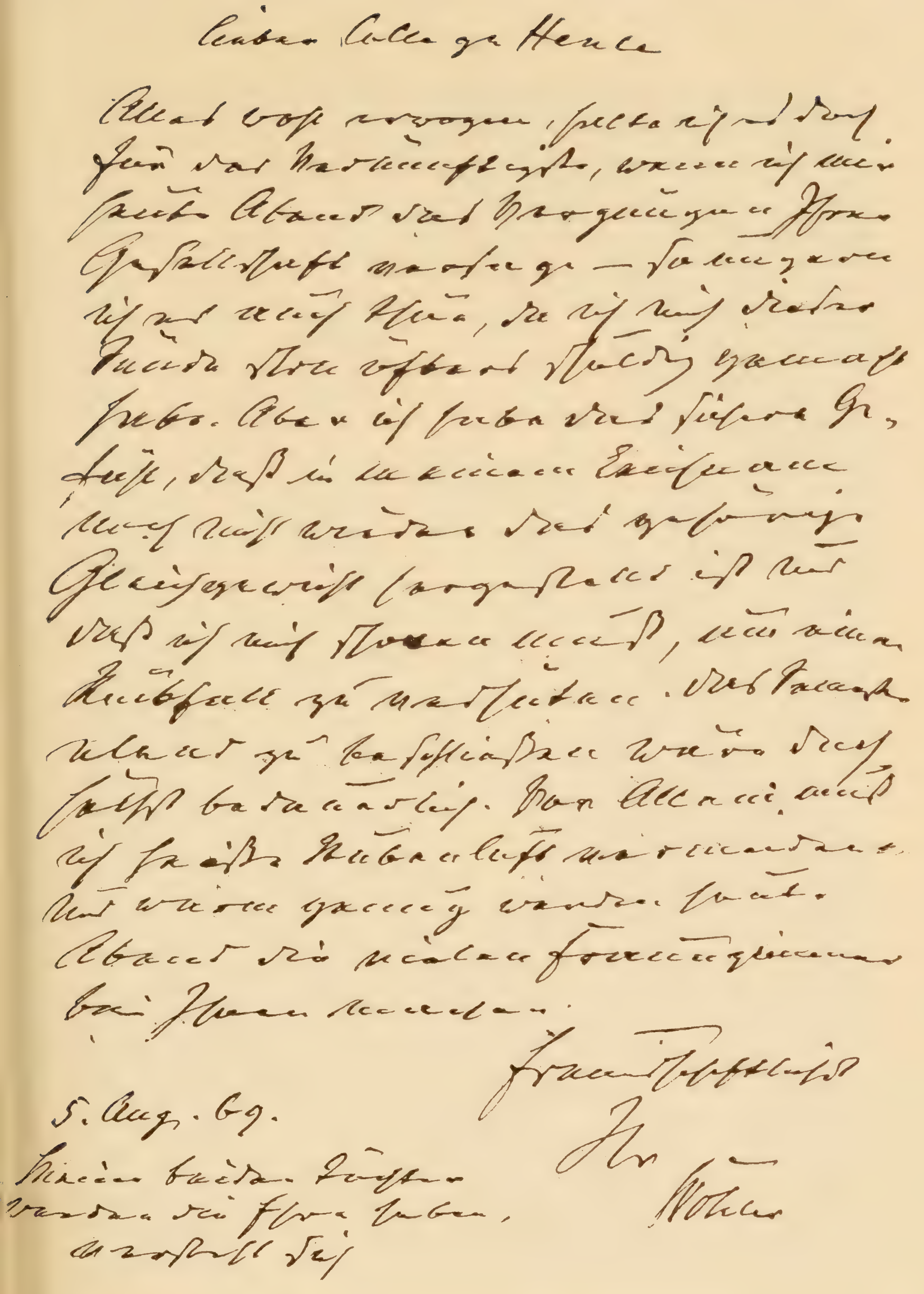
That our dear friend is unforgettable, and that the breach which his death created can never be filled, I feel as much as you do. To me too, the world looks changed since I miss the heart which shared all my joys and sorrows, and I no longer can hope to give him pleasure by my work and draw from him a word of approbation. How vague everything seems that remains to me of friends, besides the memory of this one! You may, therefore, be certain that I find your laments justified, and that I shall never tire of hearing them as long as you feel the need to express them. There is a certain equalization of justice in this, that whoever had the happiness of possessing such a man as you did, must also accept the danger of the terrible contrast which death creates. But who would, because of this danger, place a limit upon such happiness! And when parting must come, there is no better consolation than the knowledge that nothing in happiness had been missed.

In this same year, our much-quoted Friedrich Siegmund Merkel, who was then a young doctor of twenty-four, arrived from Erlangen to become Henle's prosector in Göttingen, and showed devotion not only to the master's system of anatomy, but to his daughter Anna, and thus Henle acquired his first son-in-law. Merkel later became professor at Rostock and then at Königsberg; he wrote numerous anatomical articles and pamphlets, among his chief contributions being his treatise on topographical anatomy, and his description of the tactile corpuscles of the papillae of the skin. Merkel edited successive editions of Henle's Ground-plan of Anatomy. It has been asserted that sons-in-law make the best biographers, and Merkel's life of Henle has proved indispensable to the present writer.

Henle's fourth daughter, Emma, and his second son, Adolf, were born at Göttingen. During the seventies, three more of Henle's children—Karl, Sophie, and Elise—were married. Grandchildren added to his joys, except when death chose infancy as its untimely victim. But sunny countenances were the usual visitors to the patriarch's fireside. When trouble came to any members of the household, they instinctively turned to Henle, and the hand that might have been penning an immortal idea a moment ago, would be kindly stretched forth to comfort a child's distress. Fame never disarranged Henle's simplicity. Sitting at his desk until ten o'clock, teaching for the remainder of the morning and part of the afternoon, a post-prandial application to belles-lettres followed by devotion to science until supper-time, then smoking a cigar while his wife read a novel and his daughters busied themselves with needlework, and back to his desk again where he worked until midnight, finding his recreation in his musical and literary circles, his days flowed peacefully on, and for long periods he moved merely between his home and the anatomy building. The spring of Henle's life was stormy, but its winter was mild. Tranquillity was the key-note of his venerable years.

During 1882, three of Henle's eminent friends, the novelist Auerbach, the chemist Wöhler, and the histologist Schwann, passed away. The old Henle immediately prepared a standard memoir of Theodor Schwann, the co-worker of his youth, living again through the stirring days when he and Schwann moved into one house and reconstructed biology. Henle received his diploma in 1832 and it was now 1882—a span of half a century. The fiftieth anniversary was on the fourth of April, and on that day glad outbursts of music were heard near Henle's home—the Göttingen militia's serenade; the chief burgomaster delivered the town's greetings, the students presented their teacher with a golden laurel wreath, and in the celebrations that followed, Henle saw before him some of the most distinguished scientists of Germany. It was the master's Jubilee, and his former pupils came from their academic chairs to honor him. Kölliker prepared a noble address, signed by great names, in which he said:

> You celebrate to-day the day on which just fifty years ago, you delivered your famous dissertation De membrana pupillari, and upon which you received your doctor's degree. This day is not only a day of honor for you, but a great joy for all who ever stood close to you. Permit us then, your one-time pupils and now your colleagues, to offer to you our sincere esteem and our gratitude.



Lieber College Henle

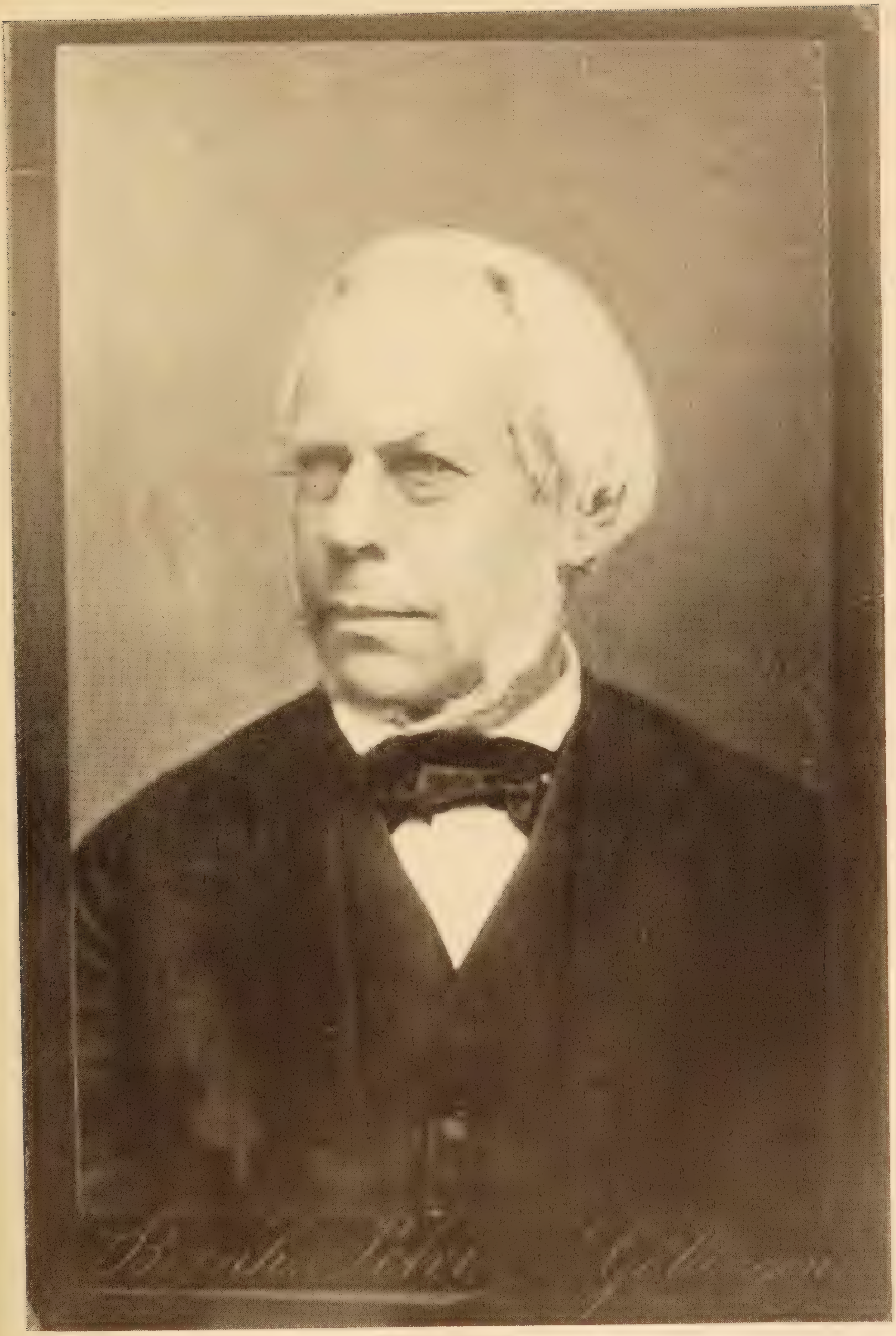
Alles wohl erwogen, halte ich es doch für das Vernünftigste, wenn ich mir heute Abend das Vergnügen Ihrer Gesellschaft versage — so ungern ich es auch thue, da ich mich dieser Freude schon öfters theilhaftig gemacht habe. Aber ich habe das sichere Gefühl, daß in meinem Leichnam noch nicht wieder das gehörige Gleichgewicht hergestellt ist und daß ich mich schonen muß, um einen Rückfall zu verhüten. Das [illegible] zu beschließen wäre doch selbst bedenklich. Vor Allem muß ich heißen Rebensaft vermeiden und [illegible] heute Abend die vielen Versuchungen bei Ihnen meiden.

Freundschaftlichst
Ihr
Wöhler

5. Aug. 69.

Meine beiden Töchter werden die Ehre haben, [illegible]

LETTER FROM FRIEDRICH WÖHLER TO JACOB HENLE



HENLE

Liebste Kinder,

Mama ist mit ihren beiden Töchtern in himmelblau u. Rosa zum Tanz gefahren; ich habe mir ausgebeten, die ersten Stunden der Spannung, bis die Tanzkarten gefüllt sind, nicht mitmachen zu dürfen u. benutze die Einsamkeit, um Eueren sehnlich erwarteten u. Ernst's mit seinen guten Nachrichten doppelt willkommenen Brief zu beantworten. Ihr Alten meine u. der Meinigen herzlichste Glückwünsche zum Kleider-Schrank, womit ich zugleich von diesem Capitel Abschied nehme; möchte die Bücherschrank-frage sich ebenso günstig lösen! Vielleicht könnt Ihr einen mit Thüren zum Schieben acquiriren, der nicht nur stehen, sondern auch aufgehen kann. Auch über die theilweise günstige Lösung der historischen Angelegenheit haben wir uns mit Euch gefreut u. beklagen nur die Engherzigkeit Friedländer's, welche Alfred die Carriere verschließt. Ob Ihr an der Vorkehr mit Entzücken große Freude gehabt haben würdet, ist eine andere Frage.

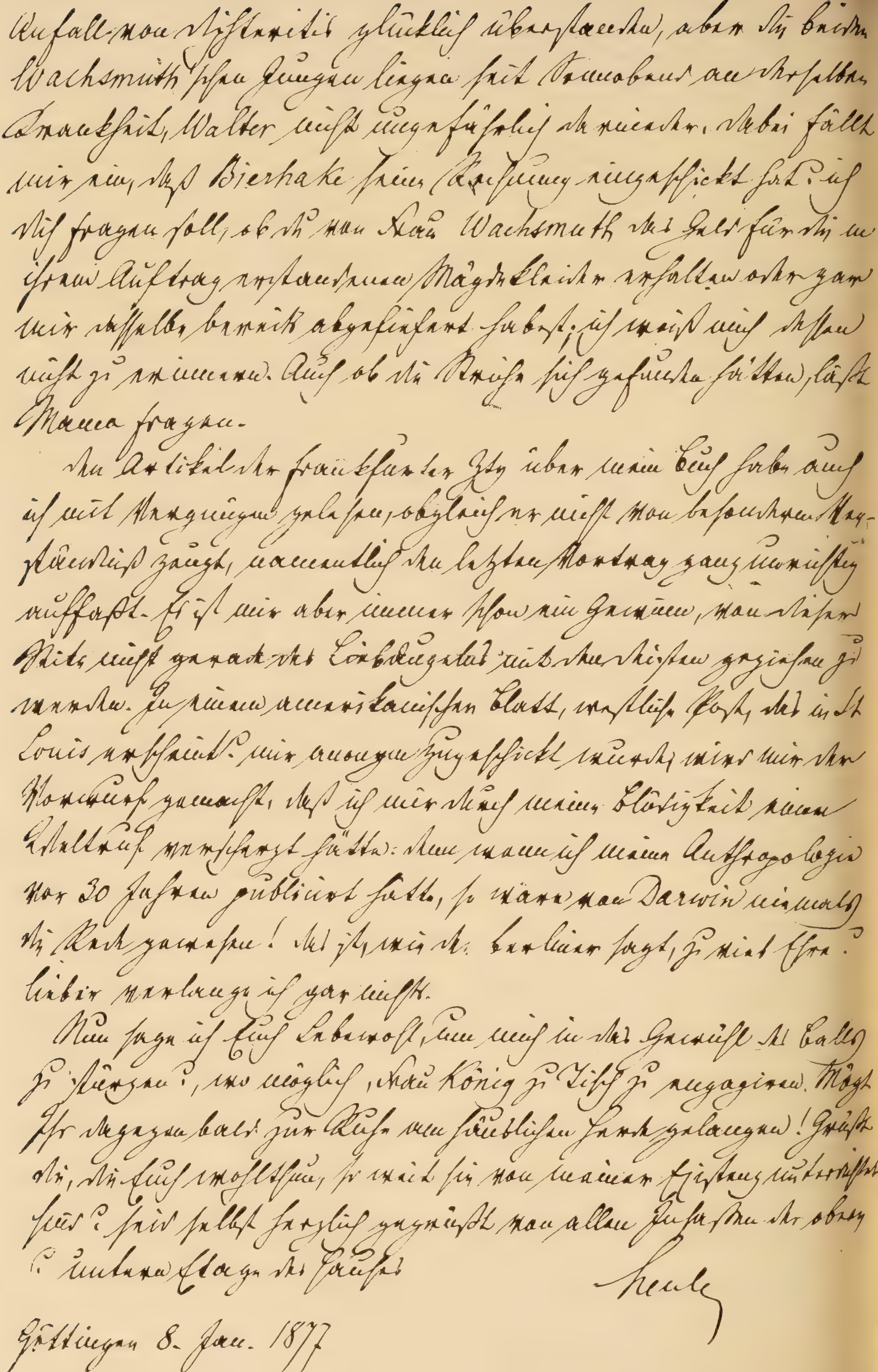
Die beiden Briefe, die ich beifüge u. der Frau Leykauff Handgeschenk lagern schon seit mehreren Tagen bei uns u. den Brief der Frau Leykauff wirst Du, liebste Liesel, wohl möglichst bald beantworten müssen, da sie ungewiß des Verbleibens des Packetchens in Sorge war. Von Frau Mürze erhältst Du ein paar sehr zierliche Manschettenknöpfe, die bei nächster, aller Wahrscheinlichkeit nach ziemlich naher Gelegenheit mitfolgen werden.

Rosalie u. ihr schöner Bräutli haben uns am Donnerstag, bei dem freundlichsten Wetter verlassen u. sind glücklich, wenn auch spät, da der bekannte Zug den Anschluss versäumte, daheim angelangt. Marie hatte in den letzten Tagen etwas viel Sehnsucht nach dem Elternhause zu kämpfen u. hat sich deshalb in einem Briefe entschuldigt, daß sie mit den Versicherungen ihres Dankes u. ihres Behagens in unserem Hause, nicht ganz taktvoll wie mir scheint, an mich statt an Mama richtete, da ich doch an dem Guten, was ihr hier zu Theil wurde, viel unschuldiger bin, als die Hausfrau. Johanna, die unsere Erörterungen über diese Etikettefrage zuhörte, nahm Anlass zu versichern sie werde ihren Dankbrief jedenfalls an Mama richten. Am besten ziehen sich die Schöll'schen aus der Affaire, die bis jetzt weder dem Einen, noch dem Andern ein Wort gegönnt haben.

Von Euren auswärtigen Geschwistern haben wir gute Nachrichten. Carl Haule der Jüngere wird am nächsten Sonntag in den Bund der Christenheit aufgenommen werden. Der Anfang von Carl's Brief, durch Beilage, hat uns etwas in Enttäuschung versetzt, da wir gebeten hatten, die Taufe wegen des florentiner Quartetts, das wir nicht zu versäumen wünschten, um 8 Tage zu verschieben. Bei weiterem Lesen waren wir aber um so freudiger überrascht durch die

Anspruchs- Vorurtheilslosigkeit, die wir besonders Hermine [illegible] zugetraut hätten u. haben mit Dank die Ueberraschung von der gl. Handlung angenommen, dafür aber versprochen, unsern Besuch an einem der nächsten Sonntage nachzuholen. Ich wäre, auch ohne Florentiner, nicht in der Lage gewesen, zu erscheinen, da ich in der Nacht hätte zurückfahren müssen, was ich meinem, wenn auch unschwer begreiflichen Katarrh nicht zumuthen wollte u. Mama wäre nicht zu haben gewesen, weil unser Gast sich darein ergeben hat, über Sonntag bei uns zu verweilen. Dann erst wird die Lücke, die d. liebe Liesel zurückläßt, uns recht zum Bewußtsein gelangen; doch ist es eine löbliche Sitte, daß man durch das Geräusch der Feste u. Gäste über das acute Gefühl der Trennung hinwegkommt. Fahret nur fort, uns so wie bisher von seinem Glück zu erzählen; es ist das beste Mittel, um zu trösten. Außerdem scheint sie des Trostes weniger, als wir erwarteten, zu bedürfen; sie hat sich beim „braunäugigen" Professor noch nicht einmal nach ihm erkundigt.

Soll ich Euch bezüglich unserer Göttinger Neuigkeiten auf dem Laufenden erhalten, so habe ich leider diesmal nur Trauriges zu vermelden. Hartmann's Krankheit, wegen deren er so spät erst, auf meinen Antrieb König's Hülfe nachsuchte, hat sich als ein Krebs des Oberkiefers erwiesen. König hat ihm den kranken Knochen u. ein Stück Gaumen herausgeschnitten, eine schmerzhafte Operation, die im günstigsten Fall eine häßliche Entstellung zurückläßt. Frau Wöhler hat ein



Anfall von Scharlach glücklich überstanden, aber die beiden Wachsmuth'schen Jungen liegen seit Sonnabend an derselben Krankheit, Walter nicht ungefährlich darnieder. Dabei fällt mir ein, daß Bierhake seine Rechnung eingeschickt hat und ich Dich fragen soll, ob Du von Frau Wachsmuth das Geld für die in ihrem Auftrag erstandenen Mädchenkleider erhalten oder gar mir dasselbe bereits abgeliefert habest; ich weiß mich dessen nicht zu erinnern. Auch ob die Briefe sich gefunden hätten, läßt Mama fragen.

Den Artikel der Frankfurter Ztg über mein Buch habe auch ich mit Vergnügen gelesen, obgleich er nicht von besonderem Verständniß zeugt, namentlich den letzten Vortrag ganz unrichtig auffaßt. Es ist mir aber immer schon ein Gewinn, von dieser Seite nicht gerade des Liberalismus und der Christen geziehen zu werden. In einem amerikanischen Blatt, welches Herz, das in St Louis erscheint und mir anonym zugeschickt wurde, wird mir der Vorwurf gemacht, daß ich mir durch meine Blödigkeit einen Weltruf verscherzt hätte: denn wenn ich meine Anthropologie vor 30 Jahren publicirt hätte, so wäre von Darwin niemals die Rede gewesen! Das ist, wie der Berliner sagt, zu viel Ehre und lieber verlange ich gar nicht.

Nun sage ich Euch Lebewohl, um mich in das Gewühl des Balles zu stürzen und, wo möglich, Frau König zu Tisch zu engagiren. Möget Ihr dagegen bald zur Ruhe am häuslichen Herd gelangen! Grüßt die, die Euch wohlthun, so weit sie von meiner Existenz unterrichtet sind. Seid selbst herzlich gegrüßt von allen Insassen der oberen und unteren Etage des Hauses

Henle

Göttingen 8. Jan. 1877

LETTER BY JACOB HENLE

A worthy pupil and friend of Johannes Müller, you followed him first into the field of comparative anatomy, but only to soon go your own way. With full recognition that the work of Schleiden and Schwann, based upon the groundwork of Bichat, had to be upbuilt and reconstructed, you created your General Anatomy, a scientific work of the highest importance, which in truth was to become the keynote of your future work. Conspicuous from the beginning, through its abundance of facts and ideas, through the masterful discussion of the physiological activity of tissue on the ground of their anatomical structure, and through the careful and just valuation of previous works, this work will remain for all times, a paragon. With the complete understanding that physiology is the foundation of pathology, you erected for yourself in this field an indestructible monument by your Pathological Researches in which you foretold, with great keenness, the latest developments in the theory of epidemic diseases. Besides this, your Anthropological Lectures, and the Journal of Rational Medicine which was founded by you and Pfeufer and continued for more than two decades, also your Yearly Reports, bear brilliant testimony to your vigorous and fruitful activity.

The climax, however, of your achievements are your researches in the field of human anatomy, and it is here where your extraordinary talent shines triumphant, not only in the way your discoveries were made, but also the manner in which they were presented. In fact, your Handbook of Systematic Anatomy is recognized as the sole work of its kind, raising the ancient and supposedly final anatomical sciences to an unprecedented degree of perfection, which must serve as a foundation for all future builders.

The picture of your manifold and unusual labors would still remain incomplete, if we were to omit mention of your activity as an academic teacher, and in this field we, your pupils and colleagues, are competent judges. There was no one more eloquent, clearer in presentation, deeper in thought and conviction, and in these respects you will always be to us an unattainable example. Accept then, much-beloved and highly revered master, our sincerest thanks, for all that you have meant to science and to us! Accept our best wishes for the glorious event which you celebrate to-day, and permit us to give expressions to our hopes, that there may remain to you many years of great happiness and blessed work.

Of the numerous other addresses, the best remembered is the one from the medical faculty of Kiel, which began with the remark that their greeting was not an isolated word out of the large sum of gratitude which had been coming to him for the past fifty years, for physicians and research-workers without number owed to him their education and inspiration. The characteristic Festschrift, the university of Göttingen's commission to the sculptor Hartzer for a bust of Henle to stand in the vestibule of their anatomical building, the decorations from various states including the government of Prussia, were other tokens of esteem which marked this jubilee. Henle's alarm that he was being honored beyond his merits, combined with his naïve pleasure at the constant stream of well-wishers and the ever-accumulating messages of congratulation, added to the sincerity and geniality of the celebration.

After the elaborate public entertainment was over, Henle's children and grandchildren gathered around him, and in their midst, decorated only with the "Jocose order of the patriarch," he was most content. To this inner group a few chosen friends were invited, among them being Henle's illustrious pupil, Wilhelm Waldeyer, who has given us this exquisite picture:

> Another beautiful phase of his being was his love and highly-developed devotion to his family. Whoever had an opportunity of seeing him in the circle of his family, will never forget how well Henle understood to make his dear ones happy. It was then that his warm heart, his delightful sense of humor showed itself. I found him thus in the spring of 1882, when he afforded me the pleasure, after the official days of his Jubilee were over, of inviting me to a celebration in his most intimate family circle, and also a year later in Herrenalb, where he and his family were spending their vacation, and I was tramping through the Schwarzwald. These days will remain unforgotten; and as he was then unbroken, so he remained to the very end.

Unbroken but not unbowed, for the autumn of 1884 found Henle a sick man. Yet throughout the winter semester, even when the physical agony of intercostal neuralgia forced him to resort to morphine, that flashing eye and winning tone still captivated the student-youth of Göttingen. Not till the official vacation began, did he seek relief—but what can Baden-Baden do for a renal sarcoma with metastasis in the vertebral column? Henle rediscovered the kidneys, but his own kidneys killed him. Upon his death-bed he spoke cheerfully and consolingly to his wife and children to the end—the thirteenth of May, 1885.

On that day, the curtain descended upon a career of dramatic completeness, for it opened with a prison and ended with a jubilee. No longer would the students see their "old Jacob," and son-in-law Merkel was called from Königsberg to become the anatomist of Göttingen—and here, in his sacred hours, he enshrined in his book the imperishable name of Jacob Henle.

IX. CONTRIBUTIONS TO SCIENCE

Henle's history does not end with his death, for though the man is dead, his work endures. Henle's first contribution to science was his dissertation on the membrana pupillaris (1832) by which he increased our knowledge of the embryology of the eye. The organ of vision continued to attract Henle: he described the histology of the retina (1839), its anatomy (1864), the physiology of the lachrymal canal (1865), the fibers of the crystalline lens (1875), the construction of the lens (1878), and its development (1882). As a result of these studies, we have several eponyms. Within the palpebral conjunctiva, Henle found structures resembling lymph follicles which are now known as the trachoma glands of Henle, or the aggregated glands of Bruch. This discovery was responsible for an ophthalmological puzzle, for it is still undecided whether these glands are normal or pathologic. The lamina basalis which forms the inner boundary of the choroid is known both as Bruch's layer and as Henle's membrane. The zone of cone-fibers and rod-fibers in the region of the macula lutea, bears the name of Henle's fibrous layer. The retinal layers exclusive of the rod-and-cone layer are known as Brücke's tunica nervea or Henle's stratum nerveum. The masses on the cornea, near the border of Descemet's membrane, are Henle's warts. After witnessing an execution, Henle wrote "Experiments and Observations on a Decapitated Person" (1852), which states his discovery that the yellow spot contains no rods but cones only.

During Henle's early years in Berlin, the medical faculty was preparing the Encyclopedic Dictionary of the Medical Sciences, and Henle was commissioned to write the articles on albumin, olein, epidermis, epithelium, eructation, excreta, sepsis (1834), falx cerebri and cerebelli, fibro-cartilage, fibrin, fauces, fat, yawning, goose-flesh, gall-bladder (1835), vascular glands, sense of hearing (1836), hallucinations (1837). He wrote also for Froriep's Notices, Hufeland's Journal, Wiegmann's Archives, Casper's Weekly, Oken's Isis, and the English Magazine of Natural History, but most of his work during the Berlin period was published in the journal with which he was himself connected—Müller's *Archiv.* His contributions to these periodicals included his observations on the acqueductus vestibuli and cochlea (1834), Owen's trichina spiralis in human muscle (1835), musculus spinalis cervicis in man (1837), mucus and pus formation, extension of epithelium in the human body, the retention of memory in the special senses (1838), the microscopic elements of milk, the construction of glands (1839), the contractility of vessels, dropsy, and the structure and formation of the human hair (1840). The outer cellular layer of the inner root-sheath of the hair follicle, surrounding the layer of Huxley, is known as Henle's layer.

After the suave Humboldt succeeded in persuading the Prussian government that its institutions were safe even with the conspirator Henle out of prison, Henle produced his habilitation-thesis, Symbolæ ad anatomiam villorum intestinalium imprimis eorum epithelii et vasorum lacteorum (1837). With this treatise the modern knowledge of the epithelial tissues begins, and the young man of twenty-eight was among the immortals. In these researches, although they were conducted with nothing better than a Schieck microscope, the investigator established names which have become permanent parts of histology, such as pavement epithelium and cylinder epithelium, and was the first to define columnar and ciliated epithelium, and the first to describe the stratum mucosum of the epidermis, and the intestinal epithelia. His pronouncement, in the following year, that "all free surfaces of the body, and all the inner surfaces of its tubes and canals, and all the wall of its cavities, are lined with epithelium," was one of the most momentous generalizations of the century, and it paved the way for the far-reaching cell-theory of Schleiden and Schwann, which in turn prepared the path for the Darwinian theory. Henle is the first author mentioned by Schwann, and on account of the fundamental importance of Schwann's work on the cell-theory—which, like Henle's researches on the epithelium, originated in the lodging-house at Number 66 Friedrichstrasse—we will quote some of Schwann's references from his "Microscopical Researches into the Accordance in the Structure and Growth of Animals and Plants" (1839):

> A very important advance was made in the year 1837, when an actual growth of the elementary particles of epithelium was proved to take place without vessels. Henle showed that the cells in the superficial layers of epithelium are much more expanded than those in the deeper strata, a fact which leaves scarcely any doubt as to their true plant-like—that is, non-vascular—growth.
>
> There is another observation of Henle's, which is opposed to the epithelium being regarded as a lifeless substance secreted from the organized tissue; I allude to the passage where he proved that the vibratile cilia, whose motion it is so difficult to explain by physical laws, stand upon little cylinders which are merely a modification of the epithelium.
>
> It often occurs that the tabular epithelial cells are not regularly hexagonal, but represent flat elongated stripes, a fact which has been observed by Henle in the epithelium of the vessels. The cells which are prolonged into cylinders constitute the other modifica-

tion in the form of the epithelial cells. They were discovered by Henle in the intestinal mucous membrane.

With regard to the formation of the epithelial cells, Henle has already proved the rete Malpighii to consist of round nucleated cells, probably the young epidermal cells, and also that the diameter of the cells increases towards the outside, so that in the fetal pig he was enabled to trace the gradual transition of the cells of the rete Malpighii into those of the epidermis.

Henle's treatises on the Narcine, a new kind of electric ray (1834), on the Branchiobdella and on the explanation of the sexual organs of the Annelida and hermaphroditic snails (1835), on the Enchytraeus, a new annelid (1837), and on the larynx, with special consideration of the larynx of reptiles (1839) constitute his independent work in comparative anatomy. In the important monograph on the larynx—which aroused the enthusiasm of old Humboldt—Henle traced the development of the organ of voice from the simple cartilage-strip in the Proteus to the complex structure in higher animals, saying in the introduction:

> As our knowledge regarding the development of the larynx and the significance of its individual parts is still very incomplete, and in fact, the origin and gradual development of the larynx in the embryos of the highest animals is so difficult to follow, I determined to undertake a comparative-anatomical research of this organ, in the hope of showing the various degrees of development in the different organisms, graduating from the lowest to the highest. In this sense, I have given a zoötomical description of the larynx in the form of the story of its development.

It is one of the oddities of science that these words should have been written twenty years prior to the publication of the *Origin of Species,* and by a man who was never reconciled to Darwinism.

All of Henle's work in comparative anatomy was accomplished under the influence of Johannes Müller, with whom he collaborated in the systematic description of the Plagiostomi.

Müller, who was a great student of fish, already knew the Plagiostomi through his study of the Myxine and Petromyzon, while Henle was familiar with the subject on account of his Narcine investigation, and when a barrel of Sicilian fish was opened in the Berlin museum at the same time that a collection of India fishes arrived, both scientists found many interesting points to discuss, and decided to systematize and extend the data on sharks and rays. As the material in Berlin, although extensive, was inadequate for their purpose, they journeyed to Rotterdam and Leyden, and later to London, everywhere accumulating scientific friends and treasures. In London they became greatly attached to the Owen family, and while the distinguished Sir Richard painted Müller's portrait, Henle improved the German of Mrs. Owen—the cleverest of female diarists. After leaving England, the travelers separated in the interest of the investigation, Henle going to Frankfurt, and Müller proceeding to Paris.

When they met again in Berlin, both had numerous observations and discoveries to report, and prepared their manuscripts for the press. In order to insure the publisher against loss, the authors agreed to purchase twenty copies annually as long as a deficit remained. "The Systematic Description of the Plagiostomi" (1838–41) was certainly a splendid piece of research, but as the Plagiostomi didn't read it, and as few human beings did, and as the practical publisher demanded that the contract be fulfilled with scientific exactitude, Müller and Henle, in the course of years, possessed scores of copies of their mutual masterpiece.

During Henle's last year in Berlin, his "Pathological Researches" (1840) appeared. In the brilliant essay on fevers he dethroned the archæus of Helmont and the sensitive soul of Stahl, and offered a rational explanation of elevated body-temperature. But the feature of the book was the essay on "Miasms and Contagia," which laid the foundation of the germ-theory of disease, as it contains the first clear statement, in modern terms, that infectious diseases are due to specific microörganisms. Henle said that if these organisms are invisible, it is not because of their extraordinary smallness, but because they differ so little from the tissues in which they are embedded, that they remain unrecognizable. The predictions which Henle made in 1840 were fulfilled, more than forty years afterward, by his pupil, Robert Koch. When the stain was introduced into bacteriology, Henle was hailed as a prophet—but in the Berlin days, when Henle and Hirschwald met for the last time, the publisher complained that the entire edition of "Pathological Researches" was still on his hands.

After his removal to Zürich, Henle discovered the Demodex folliculorum (1841), the ubiquitous pimple-mite which presides over spoilt complexions. But as Henle mistook the rear end of the parasite for its head, he was not particularly proud when this acarus was mentioned, and although he later wrote on the gregarines, the parasites of invertebrates (1845), he was never completely at home in Johannes Müller's domain of zoölogy and comparative anatomy. As the master's welcoming and guiding hand was now lacking, Henle turned to a field where he had few compeers—human anatomy. In a communication to Schoell, he says:

> With infinite joy, I now write my Handbook of General Anatomy. It is splendid to cast away a few old prejudices and to watch how here and there a light, or at least, the dawn, breaks through, and how a new principle substantiates itself in a newly founded fact. And now I work faster than in the olden times when I had to run in to you every two hours or so, with a half page of my Contagia. You had to stand a great deal from me in those days, but I have profited much, and know, therefore, that you are not regretting it. I was, in those days, almost too modest, but I believed implicitly, that which to me appeared absolute and vital, must surely have already occurred to other sensible people. Now when in spite of all the mistrust against me, and in spite of my wish to agree with the majority, I daily find fresh confirmation or refute them, I feel more comfortable and I learn to proceed without apprehension.

> My book creates sensation enough, and the critics find two ways of dealing with it: some sing me all sorts of praise, but find this and that to be startling, and believe that this and that holds entirely too fast to need to be defended against my attacks; if we were to do so and so, then there would remain little that was certain. Others belittle me in the very beginning, and hold me up as a warning example why a theoretician should not treat of practical things, and then believing they have accomplished enough, they concede the details, step by step, or break their teeth on it. Only a few, young, sanguine, and still unoccupied people, gape with open mouths, and on these my hopes are centered.

Aside from its new facts, such as the demonstration of unstriped muscle in the endothelial coats of the lesser arteries, the broad conceptions and the new principles enunciated in Henle's "General Anatomy," made its publication the most important medical event of the year 1841. Bichat was surpassed, and science acclaimed a new master. "To us young medical men," wrote Kussmaul, "a new world opened up through Henle's General Anatomy. It holds its readers almost more by the vistas it suggests, than by what already exists. Curiosity drove me to read the book, and the impression which it made upon me I can only compare with that which I received on reading Liebig's works, and I began, just as I did with the latter, to commit the vital parts of the contents to memory." Of the numerous encomiums which this work has received, none is more illuminating than the tribute of Walther Flemming, one of the greatest names in cytology, author of the aphorism, *Omnis nucleus e nucleo:*

> It was Henle, who in his researches and studies on epithelium, made the most important references to the cellular construction of animal tissue. How deeply he became absorbed in the general problem of the cell theory is plainly evident from the fact that two years after the publication of Schwann's book, he published his General Anatomy; and one may say that this contained the first real, rational tissue theory of the animal body, so comprehensive and many-sided, that it earned the admiration of the entire biological

world. If I may use a paradox, it is not a work which can be accomplished in two years, and it shows that Henle occupied himself with animal tissue in the sense of the cell theory, long before it was proclaimed.

During his latter days in Zürich, Henle collaborated with Kölliker in the publication of a monograph on the Pacinian bodies (1844), and in this year appeared the first volume of Henle and Pfeufer's *Journal of Rational Medicine* (1844–69). The contents opened with Henle's belligerent manifesto on Medical Science and Empiricism, and early issues of the magazine contained his essays on hypertrophy and tumors through checked resorption, wherein he explained the relationship between the blood and lymph streams, and on tonus, cramp and paralysis of the bronchi and expectoration, which was valuable for its observations on the physiology and pathology of breathing, and for its demonstrations of the contractility of the bronchi through the action of the smooth musculature. The journal grew in influence, and to later numbers Henle contributed his observations on cylindroma-siphonoma, a new genus of tumor (1845), on the absorption of narcotics through the lymphatics (1846), on blood analyses, on Hassall's corpuscles (1849), on the coracobrachialis muscle (1857), on the tissues of the suprarenals and hypophysis cerebri (1865). The *Journal of Rational Medicine* existed for twenty-five years, and upon the death of Pfeufer, Henle closed the magazine's career with the words: "If our successes were helpful, if our errors served as warnings, then the flag of Rational Medicine has not waved in vain."

Apart from his periodical editorship, Henle was the annual reviewer of medical progress, a task which was begun in Berlin, and extended through the Heidelberg period, far into the Göttingen times. These Yearly Reports were on the progress of physiology, pathology and pathological anatomy (1838–9), on pathology (1845–6), on histology (1844–8), and on general and special anatomy (1849–55). The anatomical reports were published in Canstatt's Yearly Reports until the publication passed into the hands of Virchow, and Henle then continued these annual summaries of anatomy in Henle and Meissner's Yearly Reports (1856–71). "One of Henle's most important activities," said Leyden, "were his Yearly Reports, a literary creation which ranks exceptionally high, and is practically the only one of its kind. These Yearly Reports were always looked forward to with great expectation."

Even as an annual reporter, Henle was too much alive to be tedious, and if his Yearly Reports were not as calmly indifferent as Hofmann-Schwalbe's, they were far more readable and stimulating. To offer simply the bare facts, to abstract all the articles on a given subject and put down the data without interpretation or comment, to present the status of every topic with the routine impartiality of an index-catalogue, did not accord with Henle's idea of what an annual report should be. He could not help becoming incensed at statements which he knew to be unwarranted, and work which he regarded as significant aroused his enthusiasm. If certain points seemed dubious, Henle laid aside the pen, and his scalpel or microscope either confirmed or confuted the author he was reporting.

These reports became famous for their commentary, and it is said that toward spring, at which time they appeared, there was an annual uneasiness among authors, and they turned the pages with shaky fingers to see how they had passed the censorship of so keen a critic. "It is not of so much importance," said Henle, "to write up pathologico-anatomical facts; in this direction our report does not even pretend to be complete, as it does not comprise all the scattered and so-called interesting instances. On the other hand, I am endeavoring to group together those discoveries which promise to disclose facts regarding the nature and organic foundation of disease phenomena, as well as experiments which are made in order to bring the connection of the phenomena upon the path indicated by physiology. As there are not only facts to be taken into consideration, but also the mode of the connection, theory and polemic cannot be avoided." In the numerous tilts that ensued, Henle was not invariably the victor. Virchow maintained that connective tissue contains fully developed cells with all their attributes, while Henle insisted that only the nuclei were present, and that what Virchow mistook for complete cells were optical delusions. He wrote:

> These optical delusions bring to mind the kind of pictures, which were rather widely distributed after Napoleon's death. At first glance, one sees an urn, and over it a drooping willow tree, and between the two a low cypress; if, however, one looks at the white space which these three objects create, one recognizes the profile of the figure of Napoleon, and once we are accustomed to contemplate the white silhouette which surrounds the pictures, they themselves become meaningless. Virchow's connective tissue corpuscles are vacant spaces, surrounded by fibers or strata, which one overlooks or considers a homogeneous mass when one becomes absorbed in contemplating the vacant places.

In this dispute, Henle went down beneath the lance of his junior, but the above-quoted paragraph is evidence that Jacob Henle was delightful even when he was wrong. It is due largely to these Yearly Reports that Henle's books are so rich in references to the history and literature of the medical sciences.

Henle's chief contribution to pathology was his "Handbook of Rational Pathology" (1846–53). It is the product of an intellectual revolutionist, and not only did it overthrow antiquated systems, but it brought forward certain speculations whose utility had not been fully established. To those who argued that we should cling to the old dead theories until the new ones proved to be of permanent value, Henle proposed the following parable:

> A pedant owned a nightingale for a long time, and had great pleasure in its song. Then the bird died. The pedant found the silence unpleasant, and went out to purchase another bird. There were but a few pilfered nests in the market, and the vendors did not know whether the eggs were fertile, or at least would not guarantee that male birds would hatch; then too, the brood would

require much attention before they grew up to be singers. The pedant thought this to be too risky, and he went away saying that he would rather keep his dead nightingale. This was conservative, but to what purpose? That the care might be wasted on the young brood was possible, but that the dead nightingale would never sing was certain.

Written in a graceful and brilliant style, opening with the dictum, "The duty of the Physician is to prevent and to cure diseases," studded with such epigrams as "The day of the last hypothesis would be also the day of the last observation," and "An hypothesis which becomes dispossessed by new facts, dies an honorable death; and if it has already called up for examination those truths by which it was annihilated, it deserves a monument of gratitude," laughing the medical devil out of existence and establishing rational concepts of disease, the Handbook of Rational Pathology created a sensation, and what made it of epochal importance, was its cardinal principle: "The physiology of the sick and of the healthy are not different, physiology and pathology are one." As Walther Flemming said:

> There is no better testimonial of Henle's success than this: that the principles which he, as a pathologist, fought for, have become a part of us to such an extent that we forget there could ever have been an opposition. For who knows to-day much of the natural-philosophico-medical system, which was in vogue during Henle's youth? One has to question the elders, as the young have but little time to devote to the history of medicine. That the systems of those days are ancient and already belong to history, is largely due to Henle. His reform-cry, Rational Pathology and Physiology are identical, became the watchword of all true physicians.

Henle's anthropological lectures at Heidelberg were exceedingly popular, and were attended not only by students of all the faculties, but by such men as the historian Gervinus and the Swiss Gottfried Keller, one of the foremost lyrists and novelists in German literature. Henle first met Keller in Switzerland, and remarked, "It was all one whether a tame young bear or a poet had been sitting at the table with us, for outside of some inarticulate growling, we heard nothing else from him." After hearing Henle's anthropological lectures, Keller interwove their essence into his chief novel, *Der grune Heinrich.* In his old age, it gave Henle much pleasure to prepare his "Anthropological Lectures" (1876–80) for the press.

After his settlement in Göttingen, when Henle felt that the time had come for his main work, he undertook a complete reexamination of the human body, a labor which he completed after sixteen years of unremitting toil; his osteology (1855), was followed by syndesmology (1856), myology (1858), splanchnology (1862–66), and neurology (1871), these installments comprising his three-volumed "Handbook of Systematic Anatomy" (1855–71), which was followed by an "Atlas" (1874–77), for use in the dissecting-room, and by a condensed presentation of the subject, "Ground-plan of Anatomy" (1880), later editions of which have been edited by Merkel. Upon the publication of the great textbook, Henle complained humorously that now he was compelled to teach according to Henle. The illustrations, whose number and excellence impelled universal admiration, were drawn by Henle himself, and the language of the text was classic. "Henle," said Flemming, "was an orator with his pen as well as in his academic chair." Henle advocated a neutral, common-to-all, Latin terminology in science, saying "There are other means of expression of love for the fatherland and mother-tongue, than the sacrifice of time and tongue which makes one say, instead of n., a., and v. cruralis, schenkelnerv, schenkelpulsader, and schenkelblutader." Henle wrote on the disadvantage of eponymic terms in anatomy, but his own name is found on the bones, muscles, vessels and viscera of the human body; examples, besides those already mentioned, are Henle's spine, Henle's fissures, Henle's ligament, and Henle's fenestrated membrane.

Special reference should be made to Henle's urogenital work. He discovered cylindric casts in the urine; pointed out that varicocele is almost invariably left-sided; described the expanded outer half of the Fallopian tube, known as Henle's ampulla; the portion of the uriniferous tubule, known as the canal of Henle; the granular mononuclear cells in the seminiferous tubules, known as Henle's cells; the fibrin formed by precipitating semen with water, known as Henle's fibrin; the remains of the gubernaculum surrounding the vas deferens and vessels of the spermatic cord, known as Henle's internal cremaster; and the striated muscular fibres encircling the prostatic and membranous urethra, known as Henle's sphincter. But his most interesting find in this field was the U-shaped turn of the uriniferous tubule which is formed by a descending and an ascending loop-tube, known everywhere as Henle's loop. Concerning this discovery, the fortunate Henle wrote one of his characteristic notes to Pfeufer:

> It is about time, my dear friend, that I inform you of the good fortune which has befallen me, of making a discovery in my old years, which is far more surprising and remarkable than any other heretofore made by me. Apart from the joy of having found something new in an organ a thousand times investigated and settled, I also enjoy the extraordinary satisfaction that my find is based on injection, and that the colleagues who credit me merely with the gift of the tongue, can no longer look down upon me from their injection-syringe.

Henle's medico-historical knowledge was extensive, and he was intimate with many scientists who made history in the nineteenth century, but he produced only three biographic memoirs: on Albrecht von Haller (1872), on Ernst Heinrich Weber (1878), and on Theodor Schwann (1882). In the year of his jubilee, Henle's scientific work was nearing its close, but in that year a man whom he had trained, and who was deeply influenced by his theory of contagion, electrified the world by his discovery of the tubercle bacillus. Forty years earlier, Henle vainly searched for microörganisms in typhoid cadavers, in smallpox material, and in the scales of scarlatina, but by his fixing and staining methods, Robert Koch substantiated his teacher's theories by demonstrating bacillus after bacillus.

Henle's last publication was appropriately in anatomy, a noteworthy monograph on the growth of the human nail and the horsehoof (1884). In sending a copy to Waldeyer, on the twenty-ninth of December, Henle wrote:

> Enclosed is the child of my ageing loins; it is a great pleasure for me to send you this, as it gives me an opportunity to renew our neglected correspondence, and to inquire as to the state of your health. I cannot say much for mine. Since the beginning of this semester, I worry along with a leftsided intercostal neuralgia, which I have been able to tame with morphium to the extent of being able to deliver my lectures. Besides the physical suffering, it also causes me great sorrow to find that it in no way conforms with my beautiful theory founded on the process of vena hemiazygos, as the exacerbations are evidently wholly independent of venous stagnations. Under these conditions, the days of our external existence pass in quietude and monotony.

In the coming spring, the old scientist reached the end of his journey, but before he passed from the sight of men, he had bequeathed to us the true knowledge of epithelium, the rational outlook upon pathology, the germ-theory on which we have built the corner-stone of modern medicine, and the most comprehensive study of the human body that had yet appeared. *Sic itur ad astra, O Jacobus Henle!*

APPENDIX—UNPUBLISHED LETTERS OF HENLE

[Written in the aftermath of the World War, when Europe seemed inaccessible, the author did not think that *The Life of Jacob Henle* would bring him in contact with the Henle family. An inquiry addressed to the faculty of Göttingen was evidently lost, and whether any of his children had survived, or where they were located if living, we had no means of ascertaining. But somehow a copy of this biography reached Germany, and a note written in English came from Heidelberg:

> It would be of greatest interest to me as well as to my sisters and brother to read the biography of our father, of which we heard through the Deutsche med. Wochenschrift, but I don't know how to obtain it, as the value of our money is in America as much as nothing. So you would do me a great kindness, if you would give us the opportunity to read the book.
>
> Emma Henle.

This letter from Henle's daughter was followed by one from Professor Rühl of Charlottenburg; and one from Professor Henle of Dortmund:

> I learn from my aunt, Fräulein Henle, that you have written a biography of my grandfather. I introduce myself to you as the son—my only brother was killed in the war—of the eldest daughter of Jacob Henle. My father, Franz Rühl, was Professor of History in Königsberg. . . . My mother and I would be very grateful to you if you would send us a copy of your biography. In the hope of giving you pleasure I am sending you herewith a picture of my grandfather in the latter years of his life, which according to my mother, is a very good one.
>
> Alfred Rühl.

> Though I was able to read your beautiful book about my father, my knowledge of English hardly suffices to write to you in that

language. But I believe you will be able to decipher my warm, deeply-felt thanks. I would have transmitted this to you long before, but I wished to send you some photographs which I think will interest you. One is a photograph of the best picture of my father at the time he had already passed his seventieth birthday; the woodcut in Merkel's book was badly made from a poorer photograph. The other is a picture of my father's first wife, Elise Egloff, after a bust which is in the possession of her son's—Carl Henle's—widow. Finally, I hope to give you pleasure by forwarding the enclosed autograph of Jacob Henle. My father wrote me no scientific letters, as at the time of his death I had not begun the study of medicine and therefore did not belong to his collegium, and unfortunately I cannot call myself one of his pupils.

ADOLF HENLE.

Then Emma Henle wrote again:

In a foreign language—my father used to say—we say what we know and not what we want to say, and inasmuch as what I know would probably be interspersed with mistakes, I shall have to ask your pardon if I express in my own mother tongue the gratitude which I felt in receiving the *Life of Jacob Henle.* I devoured the biography immediately upon receipt, but only now while I am enjoying my vacation have I had time for a thorough reading and to write to you.

The dedication gave me great pleasure; in a distant and strange land, strange people have taken such warm-hearted interest in what was our life! To feel this, alone, is grateful and inspiring. . . . It especially gave me pleasure to note how well the English language adapts itself to humor, how the merry turns in my father's letters not only lost none of their original freshness, but really gained in effect.

Over the love story you drew a poetic veil which is absent in the treatise of my brother-in-law, Merkel. His widow, my poor sister, who lost four out of her five children, has been seriously ill for a long time; I brought this book to her sickroom, and to be able to distract her pleasantly by reading your biography was a great consolation.

(Some terrible details of post-war cruelty and the tribulations of the Henle family are mentioned; we omit them in order to try to forget them). . . . How often have we thought that the peak of our suffering was reached, but it becomes worse and worse. Doubly salutary, therefore, is a friendly greeting from a distant land, a proof of sympathy, and I close as I have begun—with the assurance of warmest gratitude.

EMMA HENLE.

Little did we think when we wrote the *Life of Jacob Henle* that the time would come when one of Henle's daughters would read it to that sister who had been the wife of Merkel—such is the romance of books! After receiving these letters we turned to the pages in the biography where we had mentioned Henle's children—names which now became alive.

The ensuing correspondence with the family was of great value to medical history, for we are now enabled to make known many Henle illustrations and letters hitherto unpublished.]

The first letter is a cry of distress—Henle was marked down in anatomy by Schlemm. It is pleasant to remember that Schlemm lived long enough to see his victim become the greatest of anatomists:

LETTER I

March 3, 1833.

I begin at once with the worst in telling you that I received not the first but the second grade. Only too happy would I have been if I could have told you otherwise, and I myself give you my holiest word that up to last night I had not the slightest doubt that the final examination would result to my and the examiner's satisfaction. Everything proceeded brilliantly, but the worm which was to destroy my beautiful blossom crawled into it in the person of Professor Schlemm, who examined me in anatomy. This rascal and black hypocrite, paid me the greatest compliments to my face and behind my back wrote "good," and although in all other branches I had partly "very good," partly "excellent" as I expected, still this could not save me, as he who has but one "good" is excluded from the first grade.

As matters now stand it is rather unimportant and will perhaps not touch you as unpleasantly as myself since you possibly did not count upon it with as much certainty as I did. I have the satisfaction of every one in Berlin knowing that I have passed my examinations brilliantly and among my classmates the result caused great consternation; secondly, that I feel myself very strong in that particular branch in which I gave less satisfaction, in fact I feel equal to the deceitful examiner himself; and that I consider his judgment, especially in view of his verbal opinion, the first and surely not the last step I shall have to experience of professional jealousy. But enough of this. The people here, whom this might interest, know Schlemm and know his low character, and they know me, and I can, therefore, in confidence at least, explain the affair closely. Only I must add that I have seen the examination papers by bribing the Ministerial messenger, but that Schlemm had no idea of this, but took it for granted that I would learn the end result only, and would never know whence the blow came.

The two following letters present glimpses of Johannes Müller:

LETTER II

May 8, 1833.

Whatever I may have expected from the union with Müller, the present has far surpassed. Already at the first meeting I was convinced that circumstances have not lessened his sympathy towards my undeserving self, and now after nearly two weeks during which we spent several hours together daily, I feel the happy conviction that I have his confidence and that the many new acquaintances who pressed forward for his favor will not and cannot take anything away from my invaluable possession; also that our mutual relationship, which of necessity is somewhat delicate in several respects, does not exercise an inhibiting influence on our affairs of the heart.

From the moment I heard of Müller's possible transfer, I made up my mind never to ask for favor nor to have him use his influence in my career. I was of the opinion that even if I did gain somewhat by this request, I would lose in another direction in that the ease and geniality of our relationship would diminish, and I had full confidence that Müller would remember me when an opportunity presented itself. That I have not deceived myself is evident from his questions and from his expressions from which I can see that he is fond of me and would like to have me work near him. It seems as though I shall remain here, at least during the next winter. Müller advised me, in the meantime, to take over the work of a prosector, as later I can base my claim upon the fact that I have worked as an assistant and especially without compensation.

LETTER III

June 12, 1835.

I permit myself to quote an example in order to make clear to you the subject about which I wish to have your opinion (regarding the call to Dorpat). We are mutually agreed that Müller's wife does not find in her life with him the truly spiritual satisfaction which she craves. But she is happy in the thought of possessing Germany's first anatomist and would not exchange this for the greatest tenderness. From this point of view, *sans comparison,* I wish you would judge this matter and tell me whether the great distance, the possibility of rare meetings or hearing from each other, the thought of having me, at an early age in so influential and important a position as the successor of one of our greatest scientists, is sufficient compensation.

The next letter introduces a beautiful maiden who does not appear in Merkel:

LETTER IV

December 3, 1835.

Recently on the occasion of the baptism of the little Mayer and Sulzer they again wanted to dispose of me to a beautiful Berlin maid, who in addition to beauty bears the romantic name of Jettchen Frühling. She was the only girl and I the only youth in the large assembly. They placed us beside each other at the table, and most probably told her in advance of my virtues as they told me of her kindness, independence, her 2000 thalers and her 18 years, etc. Of what avail was it that Madam Sulzer, my immediate neighbor, lauded connubial bliss from soup to dessert. Jettchen was dumb and I remain a bachelor.

The seven letters that follow are grouped together because they all deal with Henle's detention in the Hausvogtei and his subsequent trial for high treason. At the beginning these letters were written to his parents, but before Humboldt was able to inform Henle that he was free, his mother was dead. (See chapter, Adventures in Berlin.) Prussia's mad crime against Jacob Henle can never be forgotten:

LETTER V

July 9, 1835.

You would sooner have suspected from my last letter to receive one from Dorpat instead of from the Hausvogtei; in the meantime, however, I hope that you have been duly informed by my good friends regarding my present virtuous mode of living. I hope, too, that you will not disgrace me in becoming anxious about me; I can give you my holiest word that I have no other sin on my heart except the one of which you know and from this you will be able to judge if and what I have to fear.

With the exception of certain restrictions and lack of self-determination my condition is entirely favorable. Living quarters simple, yet bearable, bed and board not worse than usual and perhaps it will do me good not to drink wine for some time. I also hope to be able, during these leisure hours to finish a certain amount of work which I long put off from day to day and which finally accumulated somewhat. *En un mot,* I lack nothing except that I cannot go out and I think to myself that it is far better that I am prevented by bolt and bar rather than by gout.

LETTER VI

July 28, 1835.

Today just a few lines to inform you that I have been set free at 2:30 after investigations which have just closed. I write you these lines in my room. More to-morrow. I have a great deal to do to-day if I wish to thank all who have befriended me.

The following note was written by brother-in-law Mathieu to Henle's parents:

LETTER VII

December 16, 1835.

During a visit there (in the Hausvogtei) all gendarmes and guards, etc., remembered Dr. Henle; he is a good soul and it is indeed a pity he left the building so soon and that there is no hope to get him back again.

LETTER VIII

January 8, 1837.

I am so happy to tell you finally that the fourth act of the great political drama in which I had the honor to participate is finished, and that the interim from the fifth to the end of the month will not be altogether too long. Last Thursday I received a verdict in official form with all the red tape: six years' incarceration, cassation, disability, etc. At the same time I was privately informed from a *reliable* source and for that reason it is the strictest secret, which I may only tell *you,* that the King mitigated all verdicts considerably and that twenty participants of the Bonn Burschenschaft, among whom is your own Jacob, who for that matter committed no crime, were pardoned unconditionally.

LETTER IX

February 6, 1837.

You have no idea how the different rumors and tales change from hour to hour; every one of my friends considers it his duty to bring newspapers, good or bad, and to give me good or bad advice as a result of it; in the meantime, I pay visits to important patrons with petitions, etc., after having wasted fourteen days in the first excitement. I thought, at first, after my patience gave out to let myself go in inactivity, just to live and dream until I was certain what was in store for me; now my patience gave out, and I am busier than ever.

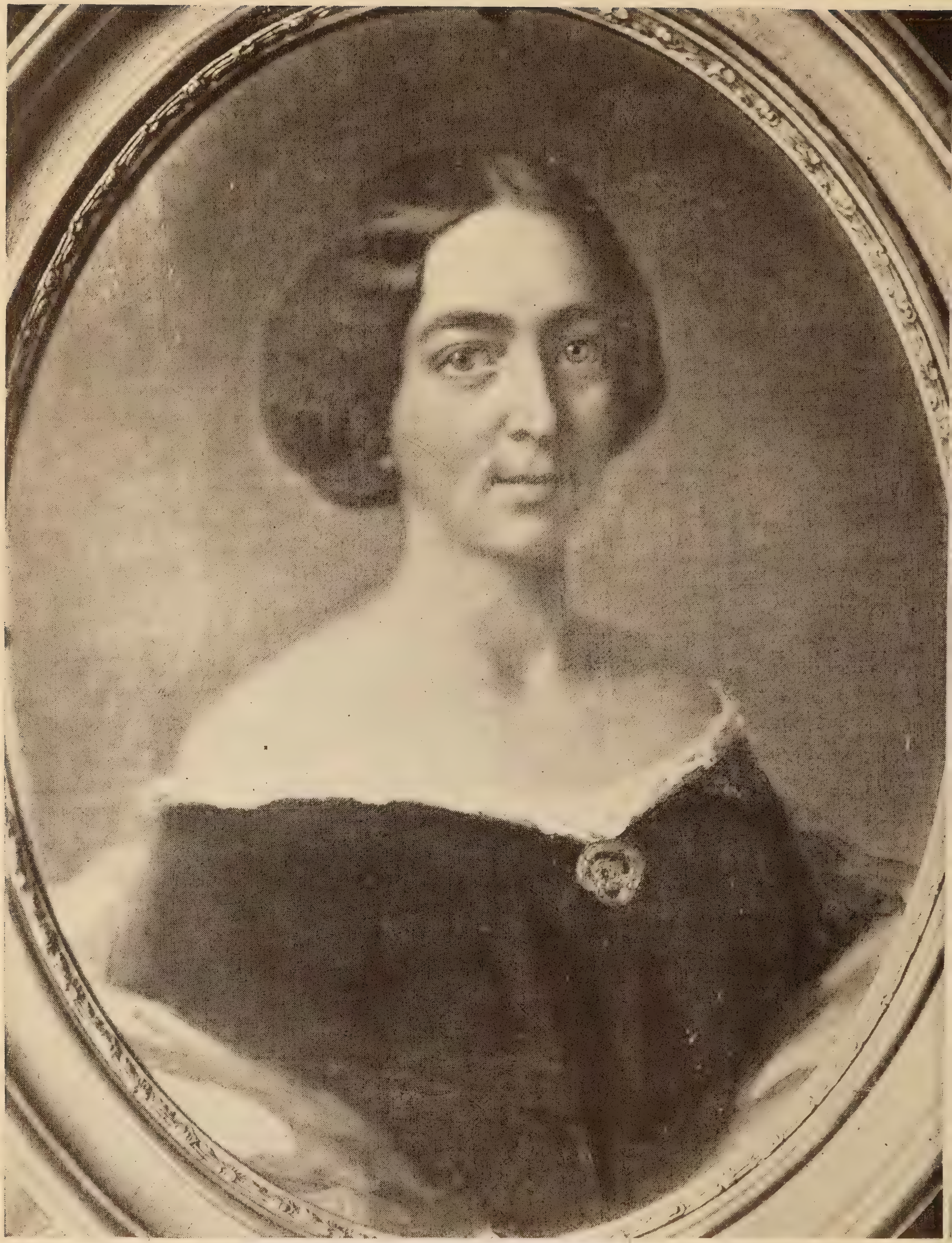
What can be done, my important patrons will do. I copy here for your delectation, a letter which Altenstein wrote to the Minister Lottum, he who wrote the report about us to the King. If you have doubts that the letter will have effect, for which I do not blame you, it will at least do you good that it had been written. Here it is verbatim:

> The former Professor Dr. Henle, who, because of his participation in the Burschenschaft (organized in Bonn) has been drawn into criminal proceedings, as I am informed, has directed a petition for mercy to His Majesty, the King. I deem it my duty to inform your Excellency that I wish to intercede in his behalf. Professor Henle belongs to the most brilliant anatomists (this, of course, can easily be put over on a General of the Infantry) and his reputation because of his achievements is so well established that already two years ago an ordinary Professorship of anatomy was offered to him at the University of Dorpat with a salary of 1500 thalers per annum which he, because of his devotion to our community, rejected. Whatever his former offense might have been, regarding which I permit myself no opinion, it is not his fault that there exists a deep, unfavorable feeling against His Majesty, the King, and the Prussian state; his aberration, due to the confusion of the times, has been expiated through long years of guiltless life, strictly devoted to science, which have earned for him great respect. So cruel a punishment which threatens him touches such a man much more painfully than young people who have very much less to lose. Through this, perhaps, an irreplaceable talent may be destroyed. This is doubly important for the State as the fate of Professor Henle will excite general sympathy in the highest degree. Should it not be possible to mitigate the general rules, that is taking away the destructive element from the individual which brings out despair and misses the way to self-correction and can, therefore, bear no good result, still, I believe, that it is of utmost importance that certain individuals who are vouched for could be pardoned without any disadvantage. I am convinced that some of the most honorable men will vouch for Professor Henle's future unequivocal behavior. I hope, therefore, that your Excellency will pardon me if I intercede for this man and I will be grateful if you will look with favor upon this intercession.
>
> I take this opportunity to assure your Excellency of my great admiration and respect. Signed: von Altenstein. [January 17,1837]

I have so maltreated my modesty that I have copied this letter for you so that you may see how this affair is considered and spoken of in high circles. As far as that is concerned neither Müller nor myself has asked the Minister for his intercession; perhaps the noble A. v. Humboldt through whose kindness I have received a copy of the above. The King has asked the Ministerial Commission for a report about me and he will decide only after he receives it.

I cannot, therefore, count on an answer for four weeks. Till then be calm, my heart! I also enclose, herewith, the evidence of admiration of another, of a somewhat more humorous nature, which I have received these days. A Jewish student named Maier (of Stralsund) who was recommended to me by an old friend

MARIE RICHTER
The Mother of Emma Henle



MARIE MATHIEU

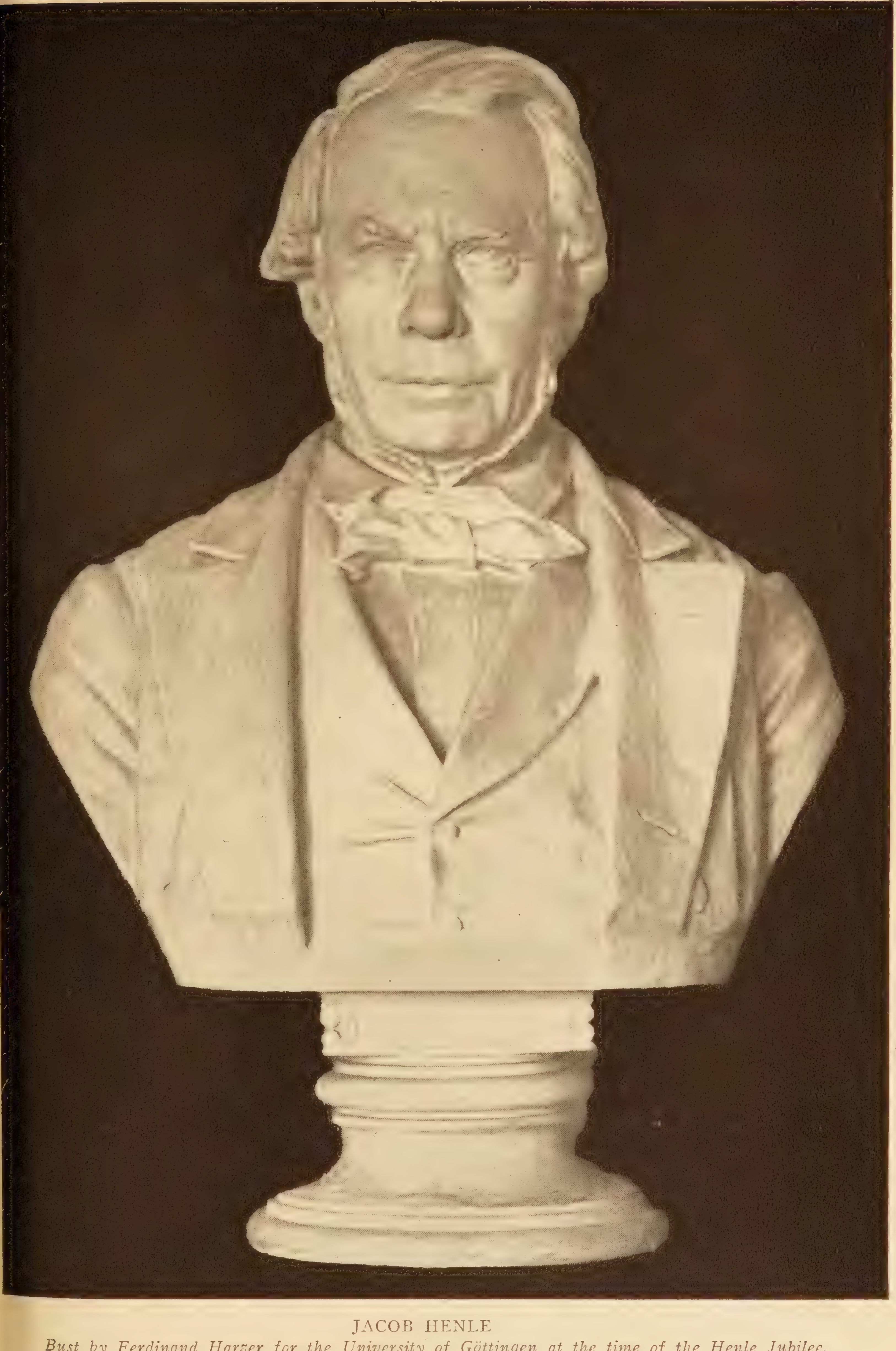
Henle's eldest sister.

EMMA HENLE

Jacob Henle's fourth daughter in her baby days. When we met Emma Henle in Heidelberg she was nearing seventy, but her resemblance to this early picture was striking.

HENLE

Photographed by Bernhard Petri at Göttingen.



JACOB HENLE

Bust by Ferdinand Harzer for the University of Göttingen at the time of the Henle Jubilee.

and whom I have, because of that, helped out with books, bones, etc., has shown me a letter from his father in Hebraic which contains a poem about me, each verse beginning with a letter of my name. The contents of this poem, unfortunately, I have not been able to learn. The boy began to translate this for me but when it came to the first line which read, "Who am I to dare to step forward before a man whose fame penetrates the world," I begged him to spare me. He assured me that further on it was still more beautiful.

LETTER X

February 23, 1837.

My fate is still undecided as you know. I, therefore, mention all probabilities. First, either I come into your local fortress; then you will know where I am and will help me to bear my hard punishment. Second, I will be pardoned but temporarily academically disabled; then I will come to you to live privately, until through the most beautiful speeches, I shall be implored not to withdraw my intellectual forces from the ambitious youth. Third, I shall be pardoned, unconditionally; then I shall first come to you to tell you and to recuperate from all this worry, and get ready for new work.

LETTER XI

March 2, 1837.

With my hat still on my head I write in great hurry that I have just received from A. v. Humboldt the authentic notification that through the King's clemency I have been freed from all guilt and reinstated in my official position. Personally, I have not yet received a written notification, however, the truth of it is not to be doubted. I have come home in all haste and am hurrying out again to bring the good news to all my intimate friends.

As previously mentioned, Henle's mother was no longer present to rejoice at his liberation; in his letter to his sisters, Henle offers them a rationalist's consolation:

LETTER XII

Undated.

I have never been able to pity anyone who leaves this world; he is far better off in the ratio to his hardships and sufferings he lived through; we mourn for ourselves at the death-bed of a loved one because a being has been torn from us upon whom we were wont to pin our hopes and ambitions, and for those whom the sorrow strikes with us. And so it is in our power to take upon ourselves a great share of the pain of the other; the loving consideration which with the long time of expectation has made of you heroes will now, too, have its strengthening influence.

Instead of all other consolation I have but one request. Remember it is merely the law of the world to honor its dead by sorrow, of the world which partly through natural curiosity, partly through commiseration, likes to feast on strange pain. If the departed still take an interest in us, then their Heaven can only be clouded if they know their loved ones are mournful, and if it be the parents' wish to continue to live in the memory of their dear ones, and what is more, to continue to influence them by their teaching and example, then a mood which paralyses their strength and spirit and body can be no welcome offering.

I can see (from your letter) that your state of mind is entirely as I have always imagined it to be in people of healthy temperament in such circumstances; as far from morbidity in avoiding any touch of the wound, as it is from the weakness of tearing it open again and again. Certainly, the only true consolation lies in the memory of the communication with the object of one's love; but this memory is at the same time a cherished possession and for that reason comforting, as only that which belongs to us entirely can personify itself in our thoughts and ultimately we possess that which is dearest and omnipresent in no other way but in our thinking about it. You all have often experienced that the parting with a possession enlightens us as to its worth, and in the acknowledgment of this worth lies a joy and exaltation which acts like a balm upon the pain of renunciation. And the greater the loss, as in our case, the greater is the consoling certainty in us, that at no time and in no event can their beloved image be clouded or effaced from our memory.

Henle in a characteristic rollicking mood is revealed in this letter to his father:

LETTER XIII

April 17, 1837.

Concerning my home establishment, my plan, unfortunately, was based on false anticipation; I wished to live more luxuriously and convinced myself to the contrary as soon as I began to look for living quarters. (He finds instead four elegantly furnished rooms and rents them immediately. The rooms are later refused him because the present occupant decides to remain.—Emma Henle.) The daughter of my would-be landlord came personally to beg me to accept the return of the deposit and to release them. They could not have sent a more appropriate emissary with this message, and as I gave in to the pretty child's pleading I actually bemoaned my fate which robbed me of the rooms and of this tailor's daughter whom I have just but seen. Deeply hurt, but in my heart glad of this aborted extravagance, I sit in the little back room for nine thalers at Hilgens and will remain here until I go to a more beautiful land where I shall receive counsel, help and consolation. Of all the promised furniture, all I now need are my white pants and a small barrel of wine which I had forgotten—so that all that I save now as a housekeeper I do not spend on the innkeeper.

In the next four letters we obtain glimpses of Henle as a traveling naturalist:

LETTER XIV

August 30, 1837.

Yesterday, great London swallowed us small people among others. We arrived after a pleasant journey at midday from one to six; to explain minutely, we remained in the Custom House, until six o'clock waiting until all those that were on board, men and women, opened their trunks piece by piece for inspection; two shillings for carrying in, two shillings for carrying out, smuggling tip to the customs' porter, who very dexterously put away for me a box of cigars which otherwise were to have cost me sixteen shillings. That was the first proof of English humanitarianism and geniality. However, the atmosphere grew pleasanter with every step from the Custom House, as we rolled slowly along in our comfortable coach through the milling crowd of people and vehicles, observing the population and the stores, and our anger changed to wonder and admiration.

In Rotterdam I was unable to write on account of the great amount of work and here in London, from sheer entertainment. The reception which awaited us everywhere, surpassed all of our expectations and the cordiality with which we were accepted into the inner family circles and the way we were made to feel at home, surprised us all. Up to the present, we made no morning call which did not lengthen till the evening. One is immediately introduced to the mistress, breakfast is served *en famille,* then the host takes us around to friends and to see collections; for dinner we must again return home with him; after dinner the ladies leave us to our scientific discussions, interspersed with jokes, and after one or two hours we are taken up to them for tea and amuse ourselves as much as possible. I get along very well with my little English; I have received many compliments about it. Even if I do not believe it all, still I can see that I am being understood and I am satisfied with it.

Our luck, besides the good recommendations, is the high regard in which Müller stands as a scientist. Many local physicians and naturalists have paid us a visit first, in order to meet him; I take it all in and comfortably snatch at whatever falls off in my direction by way of distinction. With the ladies, however, I try my own luck and I hope I succeed on account of the enthusiasm which everything I hear and see awakens within me.

LETTER XV

Zürich, August 31, 1838.

At six in the morning after smoking a cigar on the roof of the "Zur Krone" with the view of the Zürich sea and the surrounding mountains, dotted with the most charming little white houses shimmering in the morning sun, with fingers somewhat stiff by the morning air, but with a warm and happy heart, standing at the window which I could not make up my mind to shut, on the left the calmest mirror-like sea-surface with vineyards and behind them wood-clad rocks, to my right my dear little fat traveling companion sleeping in his little white bed, under me five stories, over me, after a long wait the first patch of a clear blue sky, upon me a green Circassian traveling coat, in me, the anticipation of wonderful enjoyment, before which all the beauty I have seen in the past seems a mere foretaste.

LETTER XVI

September 23, 1838.

With a heavy heart, now that I am so near you, I take my departure for a few days, and yet you yourselves would blame me if I did not accept the excellent proposition made me. The foremost naturalists of Italy and England, Prince Musignano, Owen and Buckland are going with the foremost Swiss naturalist, Agassiz, to his native city, Neuchatel, to inspect his museum; they have engaged their own conveyance and as both Agassiz and Musignano are interested in fish on which Müller and I are now working, they have urgently asked me in Müller's stead, to follow them there in order to exchange our opinions. In addition to the benefit which I will derive from the trip for our work, I think it sufficiently important to spend a few days with these men in order to make their acquaintance, which can always be of value to me and through me, to others.

LETTER XVII

Zürich, December 26, 1842.

To distract him (Pfeufer) I am taking him with me to a little improvised naturalist's meeting in Basle, to which Agassiz, Vogt and Valentin are also expected. For New Year's Eve we will be back again in time for our Wednesday society meeting, which takes place regularly although, of course, it is far less interesting than last year. I have been unsuccessful in imbuing the aged, resigned and tired-of-life members with the new spirit as I originally hoped. The society is too much a matter of corporation not to have everyone bring their hands and feet into play in order to preserve its freshness and well-being, and although I belong to the experienced dancers I have to jump and divert myself in healthy exercise instead of with female dancing partners. The music now resolves itself into regular concerts; an excellent pianist, Alexander Müller, begins every evening's entertainment with an overture, then follow songs—male quartets, operatic music, etc. The quartet and sextet from Don Juan, the first finale from Figaro, several excerpts from Abduction from Seraglio, have already been rendered.

We are now rehearsing, to our great amusement, The Doctor and the Apothecary.

After much hesitation upon declining the call to Tübingen, Henle wrote:

LETTER XVIII

December 14, 1842.

My colleagues are pleased, the students are pleased, my bootblack is pleased, I am pleased and you should also be pleased.

Henle's severity toward the reactionary elements in Heidelberg is again sensed in the conclusion of this letter to the Schoells:

LETTER XIX

November 14, 1843.

If our demands are granted, then the Government already gives proof of its intention to support us; it will love us because it holds us dear and with its help we will happily subdue the Heidelberg Faculty's pigtail, one of the longest and thickest in Europe.

We reserve for the last, a letter which Emma Henle was especially anxious that we publish. Merkel created the impression that Elise Egloff was of lowly birth, but Henle in a letter to his sister relates these circumstances:

LETTER XX

She is the illegitimate daughter of a daughter of a well-to-do Swiss, and as her mother deserted her she was brought up with her Grandfather's children and grandchildren at his home; after his death, when his property was divided, she, of course, found herself penniless, but the family detained her for a year in order to give her enough training to be able to earn her own living. After that a friendly family offered her a position as a saleswoman where she remained for a while. Later her friends in Zürich promised to find her a position where she could live a more independent life. However, the position did not materialise and she was compelled to advertise in a newspaper as a nursemaid in which capacity she found a position with a good German family. She saved enough money to establish herself in the pursuit of her trade in the home of her friend who married in the meantime, thus occupying a status for which her relatives preordained her. She remained on good terms with her relatives.

Let us conclude this appendix with an extract from Henle's unpublished testament:

. . . And furthermore, as during our life together I have always considered my wife the more practical, I forego to bind her by any restriction, desire only that in her sorrow, the justification of which I do not want to question, she deport herself with courage and calmness. If, which I do not know, anything immortal survives me, and remains in communication with her, then no greater happiness can this something experience than to know that those whom I love are joyous and happy and interested in the good which this world can give them.

TO EMMA HENLE:

The first edition of *The Life of Jacob Henle* opens with the dedication to Emilie Recht; I conclude the second edition with an epilogue to yourself.

The post-war era in which we live is swift and harsh. Beneath the wheels of the Motor Age the spirit of man is crushed. Many seem attuned to the new time, and clamor frantically for faster machines and louder radios. Without homes, traditions and principles, we join the ever-increasing current that carries us to the overwhelming whirlpool. That is why in the single year of 1927 in America, eight hundred thousand human beings were injured and twenty-seven thousand were killed by automobiles—without one official voice raised in protest. The gods of speed and force have made us mad. The Machine will destroy Mankind.

In this ruthless sweep of events, the memory of a man like Jacob Henle is anchor and shelter. To receive your letters about your father, was to achieve this protection. Communing with Jacob Henle, I was less conscious of the surrounding uproar. To live again in his presence, was to recover much that these blatant times have lost.

In the summer of 1927, coming from the pleasant mountain-village of Mergentheim with its reminiscences of Beethoven, I reached Heidelberg as the shadows gathered over the river. Seventeen years had passed since I had visited your beautiful town—but one does not forget Heidelberg amid its forest-covered hills striding the Neckar that flows to meet the Rhine. The Castle on the Jettenbühl, mighty in its ruins; the octagonal bell-tower and the cellar where the jester Perkeo still guards the Giant Tun; the paths where Goethe lingered with Marianne von Willemer; the students' tavern and the Philosophers' Walk overlooking the University—all this I remembered as if I had seen it yesterday.

A smiling figure clad in black silk, wearing an old family heirloom, like a picture out of the past—Emma Henle. How much I wanted to say and ask, but being a woman you would not answer questions until you had served supper. Then there was much talk of Jacob Henle and Elise Egloff, and the other members of your family. You showed me many photographs and old letters and some trinkets that your father had given you during your childhood. You have retained the alertness of youth, although you claimed to be verging on seventy. The ease with which you spoke English was astonishing, and your explanation that you learned it from American doctors in the Clinic has puzzled me ever since—but in your keen and humorous comments on life it was not difficult to recognize Henle's daughter.

In your little library, on the same shelf with Goethe, Schiller—and a cook-book—there stood The Life of Jacob Henle. We disagreed only when you insisted that you preferred my biography to that of Merkel. I remembered my great obligations to his excellent book, and I championed your brother-in-law. Had it not been for Merkel, I could not have written The Life of Jacob Henle.

From your window I could see the great Castle commanding the town, but spending that night in your home in the atmosphere of Henle, the granite columns of Charlemagne held no lure. When the silence spread from mountain and forest to Oberer Fauler Pelz 3, across the history of Heidelberg, against the background of the darkening conifers, Jacob Henle emerged vividly.

In the summer noon we walked through the park to the station and I wondered when circumstances would again permit me to be with Emma Henle in Heidelberg. A rare day, filched from an overactive epoch, ever to be cherished among the crowded days to come.

VICTOR ROBINSON

(1809–1882)

CHARLES DARWIN

When the carriage drew up before Darwin's house, with its ivy and its shadowy elms, the great scientist stepped out of the shade of the creeper-covered porch to meet me. He had a tall and venerable appearance, with the broad shoulders of an Atlas that bore a world of thought: a Jove-like forehead, as we see in Goethe, with a lofty and broad vault, deeply furrowed by the plough of intellectual work. The tender and friendly eyes were overshadowed by the great roof of the prominent brows. The gentle mouth was framed in a long, silvery-white beard. The noble expression of the whole face, the easy and soft voice, the slow and careful pronunciation, the natural and simple tenor of his conversation, took my heart by storm in the first hour that we talked together, just as his great work had taken my intelligence by storm at the first reading. I seemed to have before me a venerable sage of ancient Greece, a Socrates or an Aristotle.

HAECKEL.

XX

CHARLES DARWIN

[Written for the Centenary Anniversary of Darwin's Birth]

Eons ago, when the Megatherium and the Dinotherium fought, and the huge tusks of the Mastodon and the Mammoth clashed, and gigantic reptiles crawled on their bellies over the face of the earth, and the yell and howl of Cretaceous creatures resounded through the primitive jungle—the world was savage.

Later, an ape-like being grasped a hanging branch, and raised itself to an upright position, and peered into the primeval forest. This was the immediate ancestor of Man—but the world was savage still.

In the Tertiary epoch, for the first time appeared an animal that walked erect, and used a tool, and wore a garment. This was lordly Man himself—but the world was savage still.

Since that distant day, species have evolved into different forms; sea has turned into land and earth become water; mountains have crumbled into dust, and the lowest valleys have become the highest hills; customs have prevailed and perished; races have lived and died; religions have come and gone; empires have risen and fallen; one system has replaced another, which in its turn has given way to a later—and now we are veneered with culture and varnished with civilization, but, scratch us, and you will find us savage still. The lower instincts of the lower beasts survive in us. We, too, worship the primitive law of force. We do not bite with the pointed tooth, nor rend asunder with sharpened claw, but our navies ride at anchor, and at a moment's notice a million murderous guns will belch forth the stuff that makes a child an orphan.

We, too, are hunting and being hunted in a World of War.

But Nature, it is you who are the supreme warrior. Destruction is your delight. The entire earth is your graveyard. Every grain of soil is stained with blood, and every blade that grows, every flower that bows its head before the breeze, is a monument to the dead that forever rest beneath. Where is the feathered songster of the forest that has not feasted on its prey? Alas, the same lovely throats which from their leafy dwellings fill the great woods with harmony, are red with the blood of weaker victims. Then they sit and shiver at the thought of intruders more powerful than themselves.

Fear, fear, fear—everywhere is fear. Nothing is safe. All is murder. Nature is the eternal veteran, all are her enemies, and she never accepts the flag of truce. She makes a type and then she kills it. For the individual she has not the slightest regard. She cares nothing for the life which comes continually from her teeming womb.

Nature, thy mandate is chiseled on the rocks, it is echoed from the swamps to the snows, it resounds from the marshes to the mountains, the prairies know it, and the pampas tell it; it is writ across the sky, and our planet moans beneath the stern decree: flesh shall feed on flesh, and life must take life.

You destroy what you create, O Blunderer! Nature, where is thy justification? In the beginning, this earth swept through space, formless and void. Darkness was upon its face—except when the lightnings flashed and the volcanoes glowed. But the black veil lifted, the golden sun poured its warming rays on the desolate globe, and lo!—Mother Earth was pregnant. A tiny speck lay in the primitive waters, and this was life. And Nature watched our ultimate ancestor, and from that time on, her heavy hand has smitten and slaughtered.

What is it all for? Nature, is this the secret: *that thou wipest out a type to bring a higher in?* Show us then, the Perfect Man. Thou hast worked long enough for him. Through countless epochs the process has gone on. Show us, Nature, the best you have produced. We wish to see your favorite and pride.

And if you show to us a savant whose wisdom was vast, but who fawned at the feet of degenerate aristocracy, we want him not. And if you show to us a writer whose style was sweet, but who bartered his brain for gold, we want him not. And if you show to us a scientist who studied the laws of the universe, but paid toll to theologic superstitions, we want him not. And if you show to us a bishop who preached in favor of the poor, but evicted his tenants on a wintry day, we want him not. And if you show to us a poet who vehemently sang of love, but deserted his trusting wife, we want him not. And if you show to us a philosopher who wrote on the responsibilities of parenthood, but neglected his little children, we want him not.

But Nature answers: What of him, my warmest lover, my humblest servant? What of the gentle hand that placed the radiant crown on the undecked brow of Truth? And Nature has redeemed herself. She may have blundered, and she surely has effaced, but she has evolved the Perfect Man. She has unfolded Darwin the Great and Good.

Charles Darwin was a naturalist. He investigated facts. He did his work so well that to-day no thoughtful man can cast his net for specimens, or wander through the depths of a tropical grove, or explore fossil remains in a geological deposit, or scrape the barnacles from a passing ship, or study the structure of a coral-reef, or survey a belt of sand-dunes, or scrutinize a monkey's expression, or question an aborigine, or watch a crawling worm, or examine a pollen-grain, or look at a dung-rolling beetle, or dissect a curious stomach, or observe a plant under domestication, or witness an unusual hailstorm, or climb a granitic range, or view a glacier casting off its icebergs, or meditate upon the dawn of mankind, or speculate on its future destiny, without recalling some careful and conscientious passage from the unassuming thinker who dressed in dusty gray, and lived in the village of Down.

The works of Darwin! Put all his books on a shelf, stand in front of them, O Mortal,—and think! Think how much love, how much wisdom, how much patience, how much learning, how much merit, how much modesty, how much greatness, how much goodness, went into the making of them. Here is the *Journal of Researches,* which has awakened the love of nature in many breasts, and induced more than one individual to travel from one end of the globe to the other. Here is the *Structure and Distribution of Coral Reefs,* an unsurpassed example of the scientific method. Here is *A Monograph of the Sub-class Cirripedia,* and this alone is sufficient upon which to found an immortal reputation. Here is the *Expression of the Emotions in Man and Animals,* which laid the broad foundations of the modern science of comparative psychology. Here is the *Formation of Vegetable Mould through the Action of Worms,* which involves an experiment that occupied twenty-nine years, and thus serves as an inspiration to all who labor earnestly in the arduous fields of science. Here is the *Variation of Animals and Plants under Domestication,* one of the most valuable possessions in the mighty treasure-house of botany. Here is the *Descent of Man,* which fully treats of selection in relation to sex. The scientist who saw all nature at strife, saw her also in moods of love. The nightingale sings, the turtle-dove coos, the katydid babbles, the pigeon nestles close, the cricket chirps in the amorous dusk, the widow-bird spreads its caudal plumes, the butterfly shakes its brilliant wings, the sea-scorpion swims to the spawning-bed, the crocodile splashes in the little lagoon, the black-cock dances in eager passion, the starling flies to its waiting mate, the turkey struts with distended wattles, the night-jar makes a booming noise, the wood-pecker strikes a sonorous branch, the bustard rises with hurried flapping, the bower-bird builds its courting-home, the peacock extends its gorgeous train, the pheasant displays its splendid frills, the eared-seal carries its willing bride, the musk-deer emits a pleasant odor, the lion tosses its jubate mane, the linnet distends its rosy breast, the draco glides through the sweetened air—all in spring-time, all for love. Look at this; here is the *Origin of Species,* the book that changed the world, by causing its intellectual channels to flow in different courses than it had hitherto followed. The works of Darwin! You stand before the accumulated knowledge of all the ages. A thousand discoveries are within these covers. Think how deep and often that noble brow has been contracted with thought. Is the topic too vast? Does its immensity balk the mind? Then think of this one theme: From a chattering ape of the forest, swinging from branch to branch by its prehensile tail, to the scientific Darwin in his studio, writing on the Geological Succession of Organic Beings!

At the beginning of the nineteenth century, the Father of Paleontology showed—by fossil remains—that a series of different animal species had succeeded each other in the various stages of the earth's existence. Naturally, the question arose: What caused the extinction of the older species, and what gave rise to the later ones? Linné and Cuvier and nearly all others solved this problem by catastrophic theory. They claimed that overwhelming periodic cataclysms swept over the globe, wiped out every living creature, and then entirely new beings were specially created. It was a series of wholesale destructions and wholesale rebuildings. The Architect of the Universe grew dissatisfied with his work, and, therefore, threw away his old blocks and commenced to build anew.

A few intellects were too clear to be entangled in these mythological meshes. Some were keen enough to see that species undergo modification, and that the existing forms of life are descended from preëxisting ones.

To Buffon belongs the high honor of first scientifically discussing the origin of species by development. But Buffon lived in the priest-pested age of Louis xv, when the Bastille cast its shadow on the brain of every thinker. And Buffon often thought of the chains that eat out the flesh, and the dungeons which the sun cannot find, and then he ended his arguments thus: "But no; it is certain from revelation that every species was directly created by a separate fiat." (Yet Galileo-like, he must have murmured, *Eppur Si Muove!*)

In the same land was born Lamarck, a genius cast in more daring mold, who openly proclaimed his conviction that all species, including man, were descended by modification from primordial forms.

Men began to recall that Kant, in his cosmical conception, had said something of development.

Then three stars brightened the scientific sky—Goethe, Erasmus Darwin and Geoffroy St. Hilaire.

Next came the Anglo-American Wells, who recognized the operation of the principle in the distribution of the human race.

Dean Herbert and Professor Grant saw a twinkle of the coming dawn.

A little later, Patrick Matthew, building far better than he knew, wrote a book on Naval Timber, the appendix of which contained a brief but complete account of the doctrine of natural selection!

Von Buch in the Canaries, and Wollaston in Madeira were coming to the conclusion that varieties may be gradually changed into species.

Every Sunday afternoon, in the spacious halls of his great museum, a German professor walked to and fro, his hands behind his back, buried in thought. A favorite pupil sat in the angle of the window, skillfully drawing the skulls of mammals, reptiles, amphibians and fishes. "Master," asked the boy, "must not all these vertebrates, with their identity in internal skeleton, in spite of all their external differences, have come originally from a common form?" "Ah," answered Johannes Müller, as he looked at young Ernst Haeckel, "if we only knew that! If ever you solve that riddle, you will have accomplished a supreme work."

Lyell caught a glimpse of the truth. Oken was re-studying

DARWIN

Lamarck. Bates wandered through the Brazilian forests, and on the gossamer wings of the tropical butterflies read this tale of evolution.

To Treviranus, Haldeman, Horner, d'Halloy, Owen, Freke, Naudin, Keyserling, Schaaffhausen, Baden-Powell, Isidore St. Hilaire—to these, nature whispered the same secret.

Lecoq the botanist, and Von Baer the zoölogist, heard it. Wallace sat under the Malayan palm-trees, and the lazy breezes bore him a similar story. Spencer wrote on the theme and Huxley lectured.

The scientific atmosphere grew tense. Much thinking was done, but the theory of evolution remained in an unsatisfactory state. There were many scattered bricks, but no stately temple. The thoughtful ones worked by day and prayed by night, O curtain, that hidest the unknown, when wilt thou be drawn aside?

On November 24th, 1859, as if in answer to this cry, a light pierced the gloom, and the world has been illumined since.

That light was Darwin's *Origin of Species.*

A score and seven years ago, the body of Darwin—borne by two dukes, two sirs and a belted earl—was laid at rest in Westminster Abbey, next the ashes of the mighty Newton. A fitting honor, and yet a vain one, for when the altars and architraves of the great Abbey rock and reel, when its lighted and vaulted ambulatory becomes the abode of the bats, when its murals and mosaics are destroyed, when its twisted columns and its spiral bands totter in despair, when its effigies of angels and its monuments of royalties are obliterated, when the cloisters and the chapter-houses tumble in a heap, when its pointed towers and projecting transepts embrace the lowly dust, the illustrious and immortal name of Charles Darwin will still be a living force. Only when the race of man ceases to search for truth, can the luster of that name grow dim.

One hundred years ago, Darwin was born. To-day the entire intellectual world salutes him with homage. Not with the roaring of guns, but with the throbbing of brains and beating of hearts. Of all the men who ever lived it is perhaps impossible to find another who was so world-famous and so modest. An Alexander conquers a few kingdoms from barbarian subjects, and henceforth considers himself a god. A Horace writes verses which gain admiration, and he follows this by another poem boasting that he has reared unto himself a monument more enduring than brass. But a Darwin wrests secret after secret from the breast of nature, he explains what was never explained before, and at last he simply says: *Ignoramus, In Hoc Signo Laboremus.*

But in spite of his excessive gentleness he was absolutely independent, and when the cause of his beloved science was at stake, he could easily stand against all without flinching. His work was great, and so is his reward. Let anyone now think in a pre-Darwinian manner, and he becomes as much an anomaly as one who should seek for the magic stone that transmutes baser metals into gold. Within his own lifetime his name was turned into an adjective, and a thousand Darwinian writers were filling libraries with books on Darwinism.

Succeeding generations have continued the worthy and welcome task, and to-day on his centenary, his grave is the greenest in all the world. Tall men from the ends of the earth have garlanded him with wreaths that do not fade, and laurels that never die.

Among these glorious bay-trees I cast this little chaplet. It is small, and its merit scant, but every leaf of it was interwoven with veneration. It will not bloom like other coronals, though it was love that brought it forth. Accept, accept it, O Saint of Science, for I too know thee as the wonder and the glory of the universe!

(1811–1870)

JAMES YOUNG SIMPSON

I also attended on two occasions the operating theater in the hospital at Edinburgh, and saw two very bad operations, one on a child, but I rushed away before they were completed. Nor did I ever attend again, for hardly any inducement would have been strong enough to make me do so; this being long before the blessed days of chloroform. The two cases fairly haunted me for many a long year.

CHARLES DARWIN: *Autobiographical Recollections.*

Ailie stepped up on a seat, and laid herself on the table, as her friend the surgeon told her; arranged herself, gave a rapid look at James, shut her eyes, rested herself on me, and took my hand. The operation was at once begun; it was necessarily slow; and chloroform—one of God's gifts to his suffering children—was then unknown.

JOHN BROWN: *Rab and his Friends.*

XXI

JAMES YOUNG SIMPSON

A gossamer mist glided out of cloudland floating quietly and falling gently on the crags of the shore. The delicate water-dust struck the points, settled on the peaks, and broke into a vaporous fog. The opaque haze bedimmed the air, but the careful pilot in the sea below steered his passengers along the southern coast of the Firth of Forth. To the castled county of Linlithgow were the tourists bound. Toward the green knolls that divide the lake in twain were they traveling. They were on their way to the remains of the finest ruin in Scotland—the Linlithgow Palace.

They walked around the fountain whose waters had once bubbled for the delight of royalty—now as dry as a rill that has ceased to be fed by rain. They looked at the chambers in which were born James II, James V, and Mary Stuart. They stood on the very spot where King Fieryface, from the window above, had hurled the lifeless body of the Earl of Douglas. They climbed the spiral staircase till they came to the bower where Queen Margaret used to wait for James IV—who never returned from Flodden Field.

They lifted their eyes and saw the famous battlefield of Bannockburn. Here Robert Bruce defeated the English army, restored Scottish independence, and gave Robert Burns a chance to write what Carlyle called the mightiest war-ode in the world—*Scots wha hae wi' Wallace bled.*

Surely the scene is romantic enough, and many would fain dwell longer in the enchanted vicinity and imagine a chieftain fighting in every cave and cliff, while the minstrels chanted ballads o' the border. Some would sentimentalize on the kings and queens whose blue-blooded bones are mouldering like the walls of their favorite castle.

But no pen of ours can scratch a line of praise for monarch or warrior. Besides, lest it be imagined that every goose in Linlithgow is a swan, and all the lads and lassies be of blood-royal, we hasten to add that here lived, with his wife and family, a simple baker named Simpson.

Seven children tarried in the old home-nest, and grew lusty on their father's bread. They loved each other heartily, and made merry under the paternal roof. Yet one day they were warned to be very quiet. The baker himself walked on tiptoe and spoke in whispers. A nurse moved noiselessly through the rooms.

Plaintive moans were heard. Such sounds were not strange to Simpson, and still they frightened him. He knew the woman he loved was fighting the brave battle and facing the great mystery. The cries increased—the pangs of child-birth are severe. Scream followed scream—the mother labored in the agony of agonies. A heartbreaking wail which the closed door could illy bar pierced every corner of the house and pierced likewise the soul of the father. Again that shriek escaped her, and the middle of the marrow of his bones seemed to shake. He rose in his nervousness, and shuddered with an uncommon fear.

He heard gasps. Was she struggling? Was she trying to breathe? Was she dying? Ah, what a shrill, keen outcry! How long must it last? Will it never end? Is there nothing to stop such suffering? Can the physician offer no remedy to assuage such violent anguish? No, Simpson, no. The doctor who now stands in your rooms is empty-handed, but listen—the times may change.

Open the door and peep in the chamber. On the bed lies your exhausted wife. The tears are in her eyes, and her face is pale with pain. But see what she holds in the crook of her elbow—a babe.

Father, you should tell the highlanders to play a gladder pibroch than their bagpipes yet have known; the times will change, the times will change. Tell them to pipe it over the tallest hills and across the faraway seas; the times will change, the times will change. Shout to them to blow stoutly on their sturdy reeds until the new tune brings a new joy upon the earth; the times will change, the times will change. A babe who is born of woman will bring unto woman a boon!

It is we who can say these things as we look back in perspective; Simpson's thoughts were more commonplace. . . . The years passed and—

The Simpson family held a serious consultation—what was to be done with their youngest boy? It would be fine to send him to the University, but this required more banknotes than Simpson received for his oaten cakes and barley bannocks. The sacks of flour were ready, the stone ovens were heated hot, and the yeast was added to the dough till the mixture rose like a living thing—but the cold money did not rise.

They discussed the matter again, and at night the father and mother whispered low and lovingly—so the children could not hear. The University idea became the dream and desire of their hearts—James must go.

Even if poor, there is little a united family cannot do. In union there is a strength that conquers adversity and puts a quietus on poverty. When little Jamie, "the rosy bairn wi' laughin' mou' and dimpled cheeks," was only nine years, his mother died—but the idea remained. All the Simpsons agreed to save and struggle and sacrifice for the sake of the little brother, and thus it was that at the age of fourteen James Young Simpson became a student in the University of Edinburgh.

For the first two years he attended the arts classes, and then began his medical studies. The boyhood history of many men of eminence reveals the fact that they flunked in their quizzes at school, and received degrees only from the University of Life. But Simpson, being the son of poor parents, could not afford to indulge in this luxury. He seized the college curricula with both hands, and held on. He studied diligently, passed the required examinations, became a Doctor of Medicine at the age of twenty-one, and presented a thesis, *On Death from Inflammation,* which so impressed the Professor of Pathology that the recent graduate was offered and accepted an assistantship.

In this respect Simpson differed materially from a tall young fellow who entered the Edinburgh University the same year that he did. The aforesaid tall young fellow was the son and grandson of a physician, and he likewise commenced the pursuit of medicine. But he found the lectures so intolerably dull that it was impossible for him to prepare his lessons. Perhaps the cheerful fact that his father was well-to-do acted as an additional stimulant to his idleness. He soon deserted medicine in disgust, and solemnly vowed never to look within the covers of a scientific book. Yet the day came when the Royal Medical Society of Edinburgh made him an honorary member, and the strict Universities of Breslau, Bonn and Leyden honored themselves by giving him an honorary M.D. This drone did not eat in the hive of inactivity till he was stung to death by the workers. The time came when he gathered more honey than all the others. He was Charles Darwin.

Medicine in Edinburgh is all post-Renaissance—its university is the youngest in Scotland—but after that period no spot on earth is richer in medical memories. How familiar is the phrase, "an Edinburgh graduate." Who walks the great quadrangle, walks on medical history. The atmosphere of Auld Reekie is tinctured with the Old Infirmary. Its cemeteries and churchyards hold illustrious medical dust. Linked with the Modern Athens are—

Robert Sibbald, the first professor of medicine at the University, and founder of the Royal College of Physicians; his kinsman, Andrew Balfour, "the Morning Star of Science in Scotland," establishing the physic gardens with a thousand plants; Archibald Pitcairne, of such renown that he was called to the university of Leyden where he taught a Mead and a Boerhaave, the former of whom saved Pitcairne's son from execution in the Tower of London by pleading with Walpole, "If I have saved your life or the life of any member of the royal family, I owe the power to this young man's father"; the Monro dynasty in anatomy which lasted for one hundred and twenty-six years, the dull grandson nearly wrecking the university; Robert Whytt, often a pioneer in neurology, the first to describe tuberculous meningitis in children; William Cullen, master of materia medica; Joseph Black, that cautious man, one of the foremost names in chemistry; the rough-mouthed John Brown who divided Europe into Brunonians and anti-Brunonians, and that other and gentler John Brown who gave us *Horæ Subsecivæ* and *Rab and his Friends;* the numerous Gregorys and Hamiltons, and the great brothers Bell; the benevolent Andrew Duncan, who erected Edinburgh's first insane asylum over the shattered mind of the boy poet; John Barclay and the stuffed elephant of which he was so proud, and which has been an elephant indeed to subsequent curators; John Hughes Bennett, whose account of leucocythemia was the first description of a blood disease . . . the terrible days of the body snatchers and resurrectionists—criminals thriving on science because the authorities would not provide dissecting-material—Hare and Burke smothering men and women and selling the bodies to Robert Knox who had four hundred eager students to instruct—Burking the popular Daft Jaimie and Bonny Mary Paterson, the prettiest public woman in the town —Knox preserving her beautiful body in alcohol—the trial and sentence, and many carpenters offering to build a scaffold for Burke's hanging: by a strange freak of justice, Hare and his wife, equally guilty, going scot free—the mob enraged at Knox, and threatening his life—the intrepid man walking abroad with pistol and dirk concealed beneath his cloak. . . . John Goodsir, investigator of tissues, to whom Virchow dedicated his *Cellular Pathology* as "one of the earliest and most acute observers of cell-life, both physiological and pathological"; his friend Edward Forbes, the many-sided genius, a John Hunter in the making, perishing before forty; the hospital-verses of

Henley; Liston, Hercules in the operating-room; William Fergusson, the silent operator, noble founder of Conservative Surgery; Syme, his tongue stammered, his scalpel never, his character summed up in Verax, capax, perspicax, sagax, efficax, tenax; his assistant and son-in-law who had an idea which revolutionized the entire practice of surgery.

Among primitive races the male is rigidly excluded from the mysteries of the lying-in chamber, and even the father is not permitted to see the child until the navel-string has fallen off. Among civilized people conditions were not much different, and it is only within recent times that examinations in obstetrics became compulsory for the medical degree. As late as the mid-nineteenth century, physicians desiring to devote themselves to midwifery were confronted with epithets similar to those which assailed females who wished to enter the medical profession. In *Man-Midwifery Exposed,* published in Boston in 1848, fifty indignant pages teem with the refrain: "The employment of men in midwifery practice is grossly indelicate, and always constitutes a serious temptation to immorality." Immorality—over whom has that broad mantle not fallen?

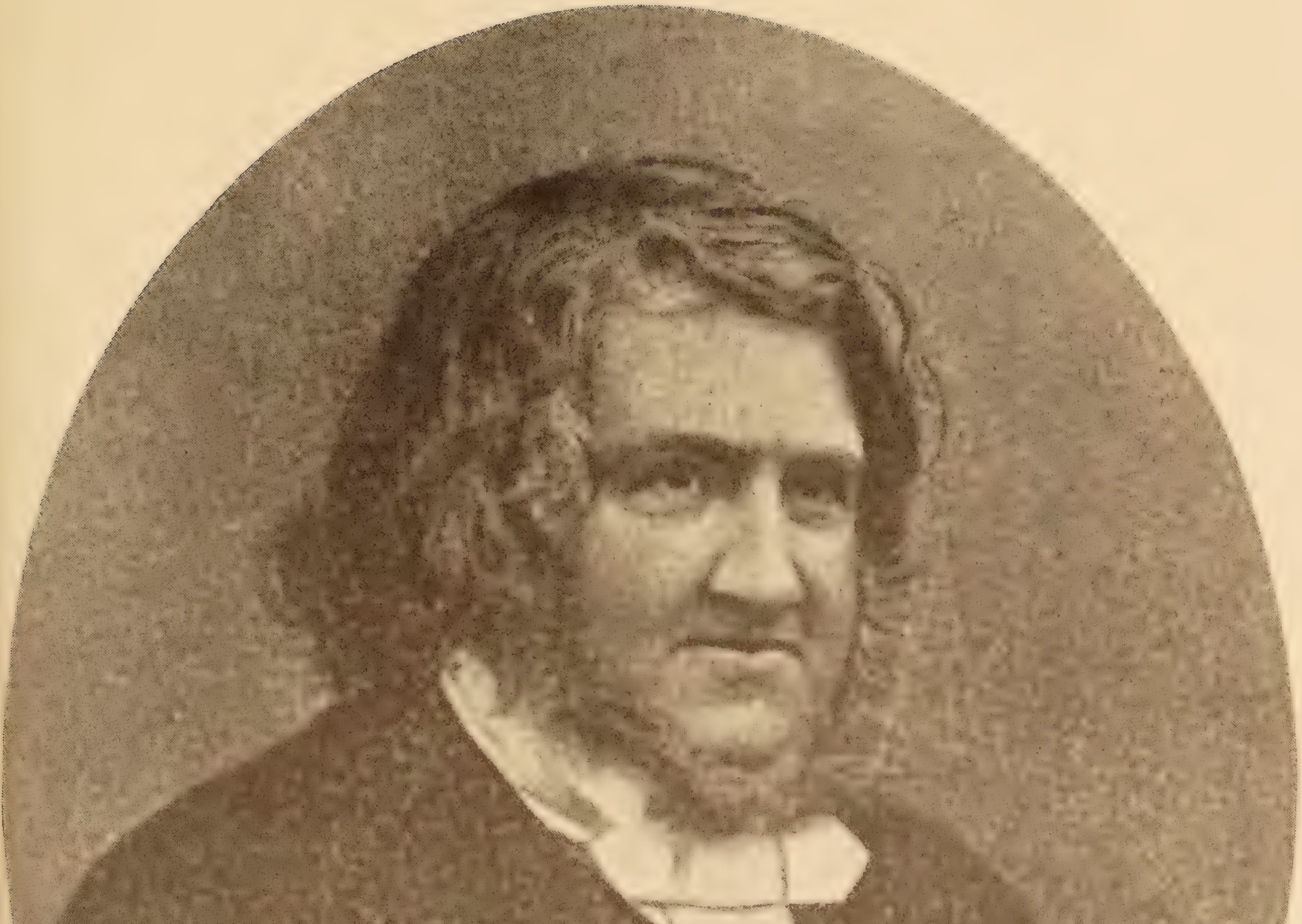
Despite this indictment, men became obstetricians, and James Hamilton, professor of midwifery at the university of Edinburgh, fought a lifetime to have his subject recognized. It is understood that the present faculty of Edinburgh is decorous, but in those days the appellation of viper, uttered in the broadest of Scottish accents, was a familiar sound in the vicinity of the quadrangle. The Senatus Academicus, like Blackwood's Magazine, had its "Leopard" and "Scorpion." The professors battled, not only with Latin quotations and pamphlets, but with fists and canes, at times requiring the intervention of unlearned policemen. James Gregory, who admitted in print that he would willingly see some of his medical enemies hanged, gave James Hamilton such a thrashing with a stick that the law deprived him of some cash, which he paid with the remark that he would gladly repeat the performance under these conditions. This Professor Gregory, big and domineering, quarreled so chronically that he wrangled himself out of the College of Physicians, but his popularity increased with his feuds, for the Gregorian roaring and brawling added to the vivacity of life in the highlands. It is sad to think that nothing remains of his memory except Pulvis rhei compositus. As for his pugnacious little adversary, Hamilton was defined by the mellow-voiced Christison as "a snarling, unfair, unfeeling critic," and this seems to have been the consensus of opinion. Hughes Bennett, not content with civil warfare, carried his altercations to foreign countries. There was no better hater in all Edinburgh than the surgeon Syme—his controversies were plentiful, personal, vindictive, and lasted a lifetime. Let us conclude these distressing reminiscences with the defense of the hard-hitting Christopher North: "The Animosities are mortal, but the Humanities live for ever."

It is on record that when Simpson attended James Hamilton's lectures, which were given in the late afternoon, he invariably went to sleep; after graduation, however, he determined to follow in Hamilton's footsteps, and on seeing the aged professor shuffle by, remarked with youthful confidence: "Do you see that old gentleman? Well, that's my gown!"

Soon afterwards Hamilton was at peace with the world, and Simpson at the age of twenty-eight applied for the vacant chair. Here we find we must again refer to the state of belligerency existing in Caledonia's metropolis. As usual, the academicians and the town council disagreed: all the chairs opposed Simpson, and probably for that reason the councillors supported him. The professors objected to his youthfulness, his celibacy, and ahem! his lowly origin. James Syme, of whom it was said that "he never wastes a drop of blood or ink," on this occasion certainly wasted a good deal of breath in talking against the baker's son. The greatest physiologist since Harvey, Charles Bell, who dwelt on the Olympian heights of science, came down to earth to write a letter against Simpson. The professors were in favor of Evory Kennedy, imported from Dublin, already master of the Rotunda and author of a treatise on obstetric auscultation. The contest that followed, resembled a political campaign: vituperation of course cost nothing, but a fortune was expended on posters, postage and printing, the latter item including octavos of testimonials. During the fracas, Simpson discomfited his rivals by suddenly marrying Miss Jessie Grindlay of Liverpool. He and his bride arose at four in the morning and worked until midnight to prepare for publication the catalogue of the private museum he had accumulated.

As the balloting drew near, Simpson wrote to his father-in-law: "The contest now lies between Dr. Kennedy and me, and each sends his spurs deeper into his horse's sides as we approach the winning post." The result was announced on the fateful Tuesday, February 4, 1840: all the thirty-three deciding members were present, and sixteen voted for Kennedy and seventeen for Simpson. Dr. Kennedy, bidding a last farewell to his alma mater, returned to the Dublin Lying-in Hospital, and Dr. Simpson wrote hastily and happily to his mother-in-law: "My dear Mother—Jessie's honeymoon and mine is to begin tomorrow. I was elected Professor to-day by a majority of one. Hurrah!!! Your ever affectionate son, J. Y. Simpson."

In this episode, we have evidence of Simpson's powers of fascination. The least known and experienced of all the rivals who entered the race, he rode to victory on his personality. His popularity broke all records, and thrifty hotel-keepers who wept over their ledgers upon Simpson's election, found themselves rich beyond the dreams of Hamilton. "When I called for Simpson," said Christison, "his two reception rooms were as usual full of patients, more were seated in the lobby, female faces stared from all the windows in vacant expectancy, and a lady was ringing the door bell." He was summoned to attend duchesses in London, many calls came from the continent, and while Simpson rushed back and forth, the steamship and railroad brought thousands of foreign ladies to the shrine of gynecology. Worshipped by women, he was regarded with extravagant affection by hard-boiled army-officers. Not only was his office overcrowded, but his home swarmed with visitors



SIMPSON

—Jessie Simpson poured out more tea than any woman in Scotland. Number 52 Queen Street became an international hotel where men of all climes, creed and color, speaking the various tongues of earth, felt the charm of Simpson. His winning ways, cordiality, sympathy, curiosity, proved irresistible. In the presence of his smile, only Syme remained grim. Simpson's enormous head with its flowing tangled locks, the melting blue eyes looking out of the broadish face, his shortened rounded limbs—"head of Jove and body of Bacchus," as Gerald Massey said of him—became as familiar a landmark in Edinburgh as Arthur's Seat or Calton Hill.

Long before he attained his fortieth year Simpson was so famous that he was able to read biographical sketches of himself, which made him laugh until he ached. It is to be regretted that Simpson did not devote some time to choosing a biographer, for he has been unfortunate in this respect. His official biographer, the Rev. J. Duns, produced a massive memoir of effusive banalities, and the life by Dr. H. Laing Gordon is a compendium of pious platitudes. No perspective, no criticism, no humor, no human weaknesses, no mistakes, all other physicians dwarfed by comparison, overemphasis of his piety, and a solemn assurance that he never gave his fellow-students anything stronger than coffee and never attended the theatre—must we accept this as the true portrait of a man?

If Simpson were really as straitlaced as his biographers maintain, it is odd that his neighbors should be convinced he broke one of the ten commandments—we refer to the one which the Rev. Henry Ward Beecher forgot so frequently. His biographers carefully avoid any reference to Lawson Tait, but Edinburgh until this very day regards Simpson as the father of this storm-petrel of modern gynecology. We know this from personal experience, and may now reveal the hitherto unpublished part of a letter by Sir Lauder Brunton, in which the eminent Scotch pharmacologist says: "Lawson Tait was, I believe, a curious instance of heredity, and although ostensibly the son of Dr. Tait, police surgeon in Edinburgh, he was said to be really the son of James Young Simpson and a lady of high rank. Tait himself considered this to be the case and stayed with Simpson on the most familiar terms. He had the most extraordinary resemblance to Simpson both in face and figure, a resemblance much greater than that of Simpson's own son." Lawson Tait was born in 1845, in which year Simpson acquired 52 Queen Street, and it is a social observation that philandering and prosperity go together. Not only did Lawson Tait live in Simpson's house, but when beginning his medical studies he assisted Simpson in various operations, including a case of inveterate coccygodoynia. This was a most unusual privilege for a freshman, and it should be remembered that Tait never graduated from the university, for this erratic and brilliant founder of modern abdominal surgery was too original to be able to pass the prescribed examinations. He obtained a license from the College of Surgeons which qualified him for practice, but his only doctorates were honorary ones from American institutions. His associate, Stewart McKay, who points out that the suggestion put forward about Tait's relationship to Simpson had the most remarkable physical proof to support it, relates the following incident:

> We may, therefore, ask: "How was Tait so fortunate as to come into such intimate relations with the most remarkable and famous medical man of the day?" The answer is, that the very general opinion at one time was that Tait was the natural son of Simpson. We had not heard this story when we first went to Birmingham in 1891. One evening when sitting with Tait on his house-boat on the Avon, we were speaking about Simpson, and casually asked him what sort of a man Simpson was in appearance. Tait leaned forward, and taking a lock of his hair he pulled it down on his forehead and said, "Now you see him." He then told us that it was said that he was Simpson's natural son. He remarked that he did not know whether it was true or not, but he gave us the impression that he was not at all displeased with the idea.

After the way Simpson is paraded by his biographers as a wooden saint, we likewise are not at all displeased with the idea.

"In coming to Europe," writes J. Marion Sims, " the man that I most wanted to see was Professor Simpson, of Edinburgh. His labors and contributions to the literature of the day were the most valuable that had been made to the growing science of gynecology." Inventor of the duckbill speculum and conqueror of vesico-vaginal fistula, Sims was the genius of American gynecology; he had followed Simpson's work closely, being the first to operate according to Simpson's method for dysmenorrhea. Simpson had represented this procedure as being unattended with danger, but in Sims' cases alarming hemorrhage had occurred. He was thus anxious to see as much of Simpson's practice as he could, particularly one of his operations on the cervix uteri, and a fitting subject was found in a young married woman who had come from India expressly to consult Simpson. "I saw," continues Sims, "that he performed the operation in theory only, but making a more profound sensation than I had ever done. Yet he insisted that he had never an accident after this operation." With that candor which caused Sims to relate his own blunders—for example, how he sacrificed a woman's life by suturing her ureters—he goes on to explain that in traveling from Edinburgh to Aberdeen and Dublin he came across doctors who laughed at his credulity concerning Simpson: they told him of Simpson's mistakes, of the dangers of his technique, and gave him the names and addresses of patients who had died under his hands.

This, of course, is an old story. Lawson Tait was so clever surgically that he could make his instruments think, but he had his mortality-statistics. Spencer Wells was the chief ovariotomist of his time, and yet his visits were often followed by funerals. When Lawson Tait was "challenged" to a duel in Berlin by August Martin, he answered: "I choose the deadliest of all weapons—the clamp of Spencer Wells." We relate these occurrences, not in detraction of Simpson, Sims, Lawson Tait and Spencer Wells, but as a further protest against perfection biographies, and as an indication that gynecology is practised, not by archangels, but by men.

In Edinburgh, amid the masters of surgery, where even the queer John Lizars found time between law-suits to introduce new operations, the scalpel of Simpson did not shine, and evidently he was fonder of the ink-well than his instrument-case. He wrote with facility, and if his writings are no longer read, it is because most clinical literature is for one generation only: in their day, all gynecologists perused Simpson's contributions. His papers on pelvic cellulitis, hematocele, and uterine cancer; his comprehensive monograph on hermaphroditism; his suggestion of version in deformed pelves; his lectures which were said to brighten the gloom of an Edinburgh winter; his devising of such terms as ovariotomy and coccyodynia, though the operations themselves are of American origin; his work on uterine displacements; his method of cervical dilatation with sponge-tents; his introduction of the polyptome, hysterotome and the long forceps; and his popularization of the uterine sound, gave such a tremendous impulse to the subject that Gynæcology and Gynæcologist began to be spelled with a capital G.

Although Syme continued to speak contemptuously of physician-accoucheurs, Simpson invaded the surgical field with acupressure—a new hemostatic process of "passing a needle through the flaps or sides of the wound, so as to cross over and compress the mouth of the bleeding artery or its tube, just in the same way as, in fastening a flower in the lapel of our coat, we cross over and compress the stalk of it with the pin which fixes it, and with this view push the pin twice through the lapel." Since a pin figures prominently in this operation, Simpson who was an accomplished Shakespearean—despite his turning his back on Mrs. Siddons—headed his brochure as usual with a Shakespearean quotation: "Tut, a pin!" When Syme read this contribution to general surgery, instead of merely doubling the tuts, he brought a copy to his class, spoke of Simpson's "vulgar insolence," and in a rage tore the pamphlet in half, consigning the pieces to the sawdust box. Simpson continued to labor on acupressure until he produced a volume of 580 quarto pages, which Syme could not tear so easily—but aside from his deplorable manners, Time sides with Syme. It is pleasant to relate that once Syme and Simpson were able to cooperate: synchronously, they fought to exterminate homeopathy in Scotland, though no doubt each wished the other in the opposing camp. If any of the remarks in this paper convey the impression that medical bellicosity was peculiar to Edinburgh, let us offset it with the recollection of Wakley the Reformer—it was not the Edinburgh Medical Journal but the London-bred Lancet which carried this characteristic pathologic item: "MALFORMATION. The following case of misplaced viscera is particularly curious. We believe, however, that several examples of a similar kind are to be found among the members of the Court of Examiners at the College in Lincoln's-Inn Field—we anticipate, for example, that when a post-mortem examination of Sir William Blizard shall be instituted, that the liver of this bitter knight will be found in his cranium, for during the whole of Sir William's life, his mouth has been performing the office of a ductus communis choledochus."

Like several Scotch physicians, Simpson was interested in archeology, and considerable ingenuity and erudition went into his antiquarian studies: leprosy and leper-hospitals in old Scotland and England, Roman practitioner's medical stamp found near Tranent, ancient Greek medical vases, syphilis in Scotland in the last years of the fifteenth century, Pictish inscription in the churchyard of St. Vigeans, Scottish magical charm-stones or curing-stones, John de Vigo's relationship to acupressure in the sixteenth century, ancient sculpture on the walls of caves in Fife, cup-cuttings and ring-cuttings on stones near Liverpool, the Cat Stane of Edinburghshire, the pyramid at Gizeh and meteorology, pyramidal structures in Egypt and elsewhere—a noteworthy achievement of one of the busiest practitioners of the age. If any additional evidence of Simpson's versatility is required, it will be found in this extract from one of his letters: "This summer I get a return of £2700 from my three Liverpool vessels, which is a better return than I ever yet got from railways. Did I tell you when I last wrote that Professor Thomson and I have taken out a joint-patent?"

Simpson was not a Thomas Young, but examples have already been given of the ease with which he entered various fields. Sagacious, a born showman, with a knack for saying the right thing at the right time, he held success in his hands. Many scientists, dying in obscurity and disappointment, if they were able to revisit this earth would be astonished to find that posterity had erected statues to their memory or had buried them in Westminster Abbey. Dr. Marshall Hall, whose discovery of reflex phenomena gave us a new insight into the physiology and pathology of the nervous system, lectured to his private students until his voice failed, yet held no academic position, never received a decent hospital appointment, and several of his most important papers were rejected by the Royal Society with undisguised scorn—even the enthusiasm of Johannes Müller in his behalf did not avail in Great Britain. "I appeal," said Marshall Hall, "from the first half of the nineteenth century to the second." It was not necessary for Simpson to make such an appeal: beneath his ample hat his contemporaries pressed the laurel.

If ever a man was born under a lucky star, his name was James Young Simpson. He ranks with the great moderns, and yet was as superstitious as his grandfather the farrier, who "was known to have had more than one serious encounter with a witch." On the subject of superstition in Scotland, however, we need say nothing, for who can add to the passages of Buckle? Simpson's answers to world-riddles indicate that as a natural philosopher he was not much above the level of his friend, Professor Horatio Robinson Storer of Boston, and yet his renown eclipsed that of a John Hunter—a druggist gave him a bottle which when opened by Simpson carried him to immortality. The story is one of the most dramatic in the history of medicine, but we must begin further back:

Who first scanned the heavens with a telescope? Galileo, we cry, but before the great Italian fitted a convex lens at one end

LAWSON TAIT

of a leaden tube and a concave at the other, he had heard of an instrument which annihilates distance and magnifies objects in a wondrous way. Some say—and with good reason—that the telescope was invented by three clever Dutchmen, Jansen, Metius and Lippershey; others claim that long before these Dutchmen saw the light, Roger Bacon knew all about optic glasses and could combine them to form a telescope. And have we not read that five centuries B. C. the Laughing Philosopher declared the Milky Way to be composed of vast multitudes of stars? Could he have seen this without some sort of a telescope? If so, then the eye of Democritus was as unusual as his brain.

Who invented the telegraph? Morse, we say, but Morse built on Henry, who built on Steinheil, who built on Weber and Gaus, who built on Faraday, who built on Davy, who built on Nicholson and Carlisle, who built on Galvani and Volta, who built on Don Silva and Cavallo, who built on Lomond, who built on Lesage, who built on Stephen Gray, who built on others, back and still further back.

Whom shall we call the Father of Anesthetics? Here we must pause, for ever since mortal felt a twitch of physical pain, he wished to drink of Lethe. Indian hemp or hasheesh seems to have been the first anesthetic, for it is believed that this was the plant with which Egyptians numbed their patients before surgical operations; it is further believed that this was the sorrow-easing drug which Helen gave to Ulysses in the *Odyssey*. It is possible, however, that in both of these cases opium was the medium, or perhaps a mixture of the hemp and the juice of the poppy.

More than six thousand years ago the Babylonians used mandragora, and there are Biblical and Talmudic references to soporifics.

Of course the keen Greeks and Romans knew several remedies to assuage pain and paralyse sensation. Allusions to them are found scattered through the works of Dioscorides, Pliny, Celsus, Paulus Ægineta and others. "If anyone," wrote Apelius, "is to have a limb mutilated, burnt, or sawn, he may drink half an ounce of mandragora with wine; and while he sleeps the member may be cut off without any pain or sense."

In the third century the Chinese doctor Hao-Tho anesthetized his patients with ma-yo, which was probably the hemp plant.

During the Middle Ages the leading apostles of anesthesia seem to have been Hugh of Lucca, the inventor of the Sleeping Sponge, and Guy de Chauliac, one of the chief figures in the history of medieval medicine. In his *Chirurgia Magna* is this passage: "Some prescribe medicaments which send the patient to sleep, so that the incision may not be felt, such as opium, the juice of the morel, hyoscyamus, mandrake, ivy, hemlock, lettuce. A new sponge is soaked by them in these juices and left to dry in the sun; and when they have need of it they put this sponge into warm water and then hold it under the nostrils of the patient until he goes to sleep. Then they perform the operation."

References to anesthesia are not infrequent in the literature of the times. In Boccaccio's *Decameron* a surgeon of Salerno discourses of his soporific. The Shakespearean student will recall the master's mention of mandrake: Iago tells Othello of it, and Cleopatra calls for mandragora when Anthony is away, to sleep out the great gap of time. Another dramatist of this period, Thomas Middleton, in his *Women Beware Women,* wrote:

> I'll imitate the pities of old surgeons
> To this lost limb, who, ere they show their art
> Cast one asleep, then cut the diseased part.

Still another Elizabethan poet—the youth who flung away his genius in a brothel as carelessly as a fisherboy casts a pebble in the sea—makes Barabbas in the *Jew of Malta* say:

> I drank of poppy and cold mandrake juice,
> And being asleep, belike they thought me dead,
> And threw me o'er the walls.

In truth at this period anesthetics appeared to more advantage in poetry than in practice. The outcome was always uncertain, and in the seventeenth century anesthesia was almost wholly forgotten or abandoned.

But then followed the Chemical Century, when numerous gases were discovered, and experimenters began to inhale all sorts of vapors, and Humphry Davy learnt the anesthetic virtues of nitrous oxide which had recently been discovered by Priestley, and Michael Faraday found sulphuric ether to be possessed of similar properties. In his *Researches Chemical and Philosophical,* published in 1800, Davy wrote: "As nitrous oxide in its extensive operation seems capable of destroying physical pain, it may probably be used with advantage during surgical operations in which no great effusion of blood takes place."

It is strange that a statement so richly suggestive should have been barren of results. But more than another generation had to pass before the subject was further investigated, and it was in another country that anesthesia first became an effective blessing. Practically speaking, anesthesia is an American discovery. In the fourth decade of the nineteenth century, teeth were painlessly extracted and amputations performed under the influence of nitrous oxide and ether. It is an epoch of glory and shame, for on the trail of this revelation—unquestionably one of the grandest in all medical history—strode tragedy, suicide, scandal, greed and law-suits. The discovery was made for the benefit of humanity, but human selfishness is written large all over it. Priority and patent-rights—these were the questions that were angrily argued between the suspicious disputants. Even yet the dust of hatred has not settled, and looking through the haze of misunderstanding it is still impossible to sum up the merits of the case; though we know alas! that out of the four principal claimants, one died in obscurity, the second died broken-hearted, the third died in a lunatic-asylum, and the fourth died by his own hand in jail.

But besides Long, Morton, Jackson, and Wells, at least a dozen other Americans were among the pioneers of anesthesia: Colton, Riggs, Clarke, Marcy, Warren, Hayward, Pope, Bigelow, Holmes, Godman, Wood and Bache.

Warren's ever-repeated exclamation at the end of the first public major operation under ether, "Gentlemen, this is no humbug!" was matched by Bigelow's solemn words: "I have seen something to-day that will go round the world." That was on October 16, 1846, and as soon as the news reached England the Gower Street dentist, James Robinson, etherized and painlessly removed a lady's molar. Two days later, at the University College Hospital of London, anesthesia had its great European trial. Among the students in the crowded amphitheatre sat a handsome Quaker youth, but that day Joseph Lister was only a spectator in surgery. William Squire was the anesthetist, and before the operation began he asked if anyone would volunteer to try the ether. As no one responded, the hospital porter, strong Sheldrake, a skilled boxer, was requisitioned and placed upon the table. He inhaled the ether for some seconds, then springing up struck the anesthetist a blow which toppled him over, brushed aside his assistants as if they were children, and leaped with shouts among the students who dodged and fled as best they could. Falling upon the top bench, he was seized and sat upon until reason returned. On that day, farce and history were one moment apart:

A gowned giant enters the arena. It is Liston, driven from Edinburgh by the success and sarcasm of his cousin Syme. Liston had often annoyed Syme . . . writing in the subscription-book of Syme's hospital, "Don't support quackery and humbug"—the suit for libel and Liston's apology. . . . Little Syme lecturing, and Liston picking up an ape's skull and pointing out its resemblance to the lecturer. Syme, younger than Liston, forging ahead, gaining deserved recognition as one of the greatest surgeons that ever lived, securing the chair of Edinburgh—by purchase? Liston likewise acquiring renown, his methods of crushing stone, excising the jaw and amputating thighs being the despair of operators. In the pre-anesthetic era, when every touch of the knife meant agony, he was the best surgeon who operated fastest. Liston was a wizard with the scalpel. He amputated a thigh by compressing the artery with his left hand and cutting and sawing with his right—if he needed the use of both hands he held the saw between his teeth. Liston's knife flashed, and if you sneezed or winked or turned your head, you missed the operation because it was over. In spite of his speed, Liston had harrowing memories. Patients shrieked and tore madly at their straps, and had to be held down by force . . . a man to be cut for stone, losing his courage on the operating-table, rushing down the long corridor, locking himself in the lavatory. . . . Liston makes a battering-ram of his powerful shoulder, breaks down the door, carries the patient back, and operates with success.

If the report from Massachusetts is true, these horrors already belong to the past, and a new era has dawned. But is it true? Is there not a sneer on Liston's lips as he addresses his audience: "We are going to try a Yankee dodge to-day, gentlemen, for making men insensible." A butler named Frederick Churchill lies before Liston, and for the first time in his career the surgeon stays his hand—only when the patient sleeps, Liston removes his diseased thigh. Churchill, who has felt nothing, awakes from insensibility, and does not know the limb is off until the towel is lifted and he is shown the stump. The rough-mannered Liston whose voice so often struck terror to his associates, trembles with a strange emotion. This feeling sweeps through surgeon, patient and every spectator—they have seen the conquest of pain. It was Robert Liston's gentlest and greatest moment: in less than a year an aortic aneurism kills the mighty man in his prime, but ether has already become as indispensable to the surgeon as his sharpened scalpel.

Simpson now had an inspiration: he would apply anesthesia to midwifery—and while we cannot decide upon whom to place the badge of Founder of Modern Anesthesia, one event in the history of relieving pain is certain: the first physician openly to use an anesthetic in a case of childbirth was James Young

Simpson. In this he had no precedent: he was inspired by the example of no one, unless perchance it were the murdered spirit of Lady Eufame Macalyene, who in this very city of Edinburgh was burnt at the stake by the ecclesiastics for attempting to deaden the pangs of labor by artificial means.

The first drug which Simpson employed in his obstetric case, January 19, 1847, was naturally ether. Not being quite satisfied with its efficiency, he searched for an anesthetic of more energetic action. With George Keith and Matthews Duncan he tested the properties of the vapor of iodoform, acetone, benzine, chloride of hydrocarbon, nitrate of oxide of ethyl, and various oils and gases. None of these caused him to conclude his research. Every morning James Miller, known as the surgeon who disliked to operate, looked in at 52 Queen Street—he was alternately Simpson's friend and enemy—to see whether the experimenters had survived.

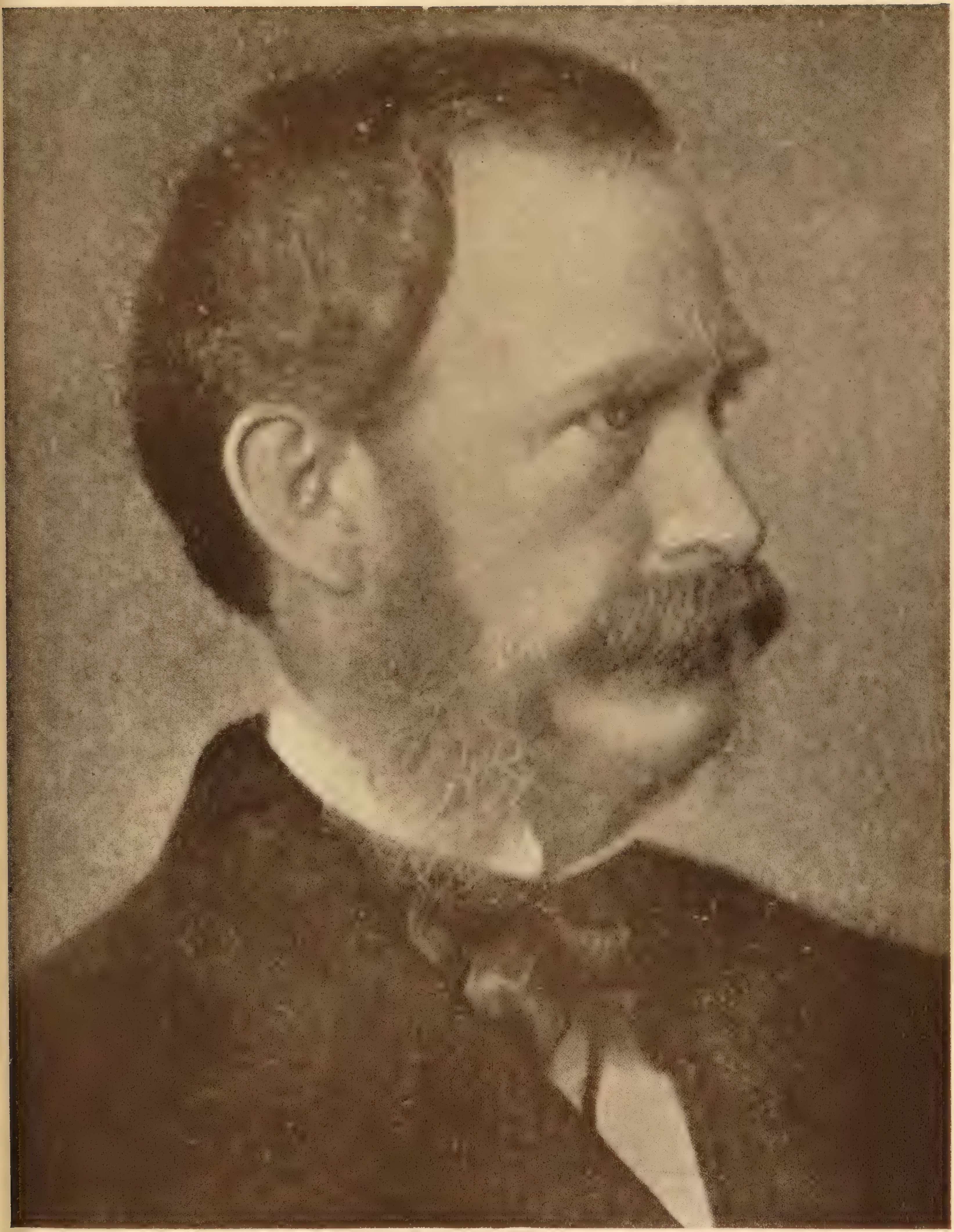
On the evening of November 4, 1847, a date worth remembering, Simpson and his assistants inhaled several substances without any marked effect. Ether still remained the unrivalled anesthetic. At this moment Simpson happened to remember that a Liverpool chemist named David Waldie had spoken to him about a certain heavy colorless liquid. Simpson looked for the bottle, but could not find it. Probably when he was on the point of remarking that it wasn't of much importance anyhow, the amber-colored bottle was pulled out from the bottom of a heap of waste paper. Simpson scrutinized it again, and shook his head dubiously. It seemed to him too ponderous to be of much value.

But he took out the stopper, poured the contents in the tumblers, and the three inhalers eagerly shoved their noses to the brim. They arose, happier than when they had sat down. Dr. Keith's eyes grew bright and he laughed heartily, Dr. Duncan waltzed around the room, and Dr. Simpson wiggled his toes and would have stood on his learned head for a doughnut. Some ladies came into the room—these experiments were conducted in Simpson's dining-room and not in a laboratory—

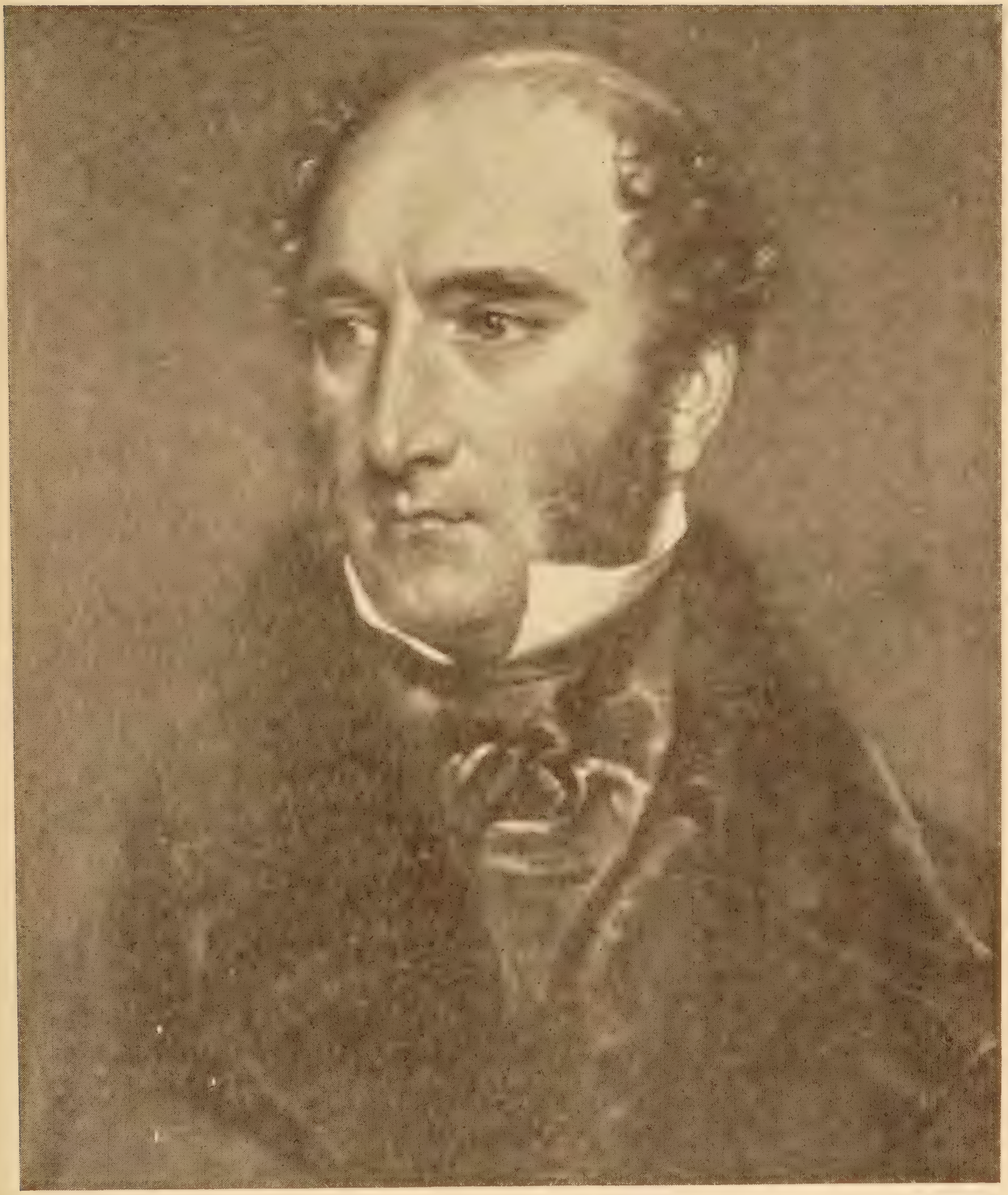
CRAWFORD WILLIAMSON LONG
Medallion designed by R. Tait McKenzie.

Horace Wells

Courtesy of the Surgeon-General's Library, Washington, D.C.



WILLIAM THOMAS GREEN MORTON



ROBERT LISTON

and the gentlemen were remarkably amiable. They were more polite than Chesterfield, and the silvery stream of continual conversation which unceasingly flowed from their gifted tongues would have worried the mouth of Richard Brinsley Sheridan. The delighted ladies did not quite know what to make of it, for they did not understand that the doctors were historically drunk on chloroform. Suddenly the scene changed —Simpson and his crew became confused, lost their senses, and fell to the floor.

When Professor Simpson awoke and made contact with his surroundings, he realized that the usually alert Duncan was snoring, that Keith's legs were attempting to overturn the table, and that he himself was prostrate. His thought was as follows: "This is better than ether." One of the young ladies, Miss Petrie, wishing to prove that she was as brave as a man, inhaled the chloroform, folded her arms across her breast, and fell asleep chirping, "I'm an angel! Oh, I'm an angel!"—but Simpson was too occupied just then to search for her wings.

He soon prepared a paper on Anesthetics which he read before the Medico-Chirurgical Society of Edinburgh, and dwelt especially on the superiority of chloroform over ether—which is not correct, but Simpson was reared in the hotbed of polemics. He began at once to use it in his obstetrical practice. One would naturally suppose that the whole world rose as one person and hailed Simpson as blessed, and that women especially felt like traveling from the ends of the earth to cast flowers in his path. Instead of this adulation, however, he was attacked on so many sides that like the lofty Milton he might have said:

> . . . a barbarous noise environs me,
> Of owls and cuckoos, asses, apes and dogs.

The controversy grew so bitter that had Simpson been a Semmelweis he might have become insane, and had he been a Horace Wells he would have killed himself. But Simpson had the courage which defends and the courage which attacks. His was a warm and tender heart, but these desirable qualities did not prevent him from showing proper temper at unwarranted conservatism and unnecessary stupidity. He was no meek-cheeked weakling, and his hand was not lily-fingered. He was the leader of a great battle and he fought with a clenched fist, for the man who is carrying forward a great truth cannot waste time with the Bransby Coopers of the profession.

Unfortunately, it was not only the unscientific rabble which shouted at Simpson. Meigs of Philadelphia, Ramsbotham of Great Britain, Scanzoni of Germany—men of brains and skill—opposed the innovation. It seems that whenever a great radical steers his progressive ship over the waves of improvement, there is pitted against him a great reactionist, who by the weight of his authority beats back the advancing craft, and causes it to tremble and flounder among the sands and shoals of established usage.

It is interesting to recall the arguments which were urged against Simpson's introduction of anesthetics into obstetrics. Objections were seldom raised on the ground that the administration of chloroform would prove injurious to either mother or child. The disputants did not claim that the anesthetic would interfere with the natural progress of labor, or impede the uterine contractions, or that there would be an increased elimination of nitrogen in the new-born babe. Such statements—though incorrect—would at least be entitled to the gravest and most careful consideration. But such arguments were not advanced. Instead, much stress was laid on the fact that an anesthetic sometimes arouses the amorous feelings, and that some women who have been under the influence of ether or chloroform have confessed that while anesthetized they believed they were engaged in the act of coition. That such occurrences were exceptional and unusual, while labor-pains were otherwise, was not taken into account, and it was both seriously asserted and solemnly maintained that if anesthetics were used in obstetrics the holy pangs of labor would be metamorphosed into exhibitions of sexual passion.

It was further argued that the maternal instinct was in danger of being abolished, as a mother could not love children whom she had brought into the world without suffering.

But even these were not the main contentions. Indeed, they were only breezes in relation to the whirlwind which was to overwhelm him; they were only the lapping of the waves in comparison with the howling storm which was to seethe about him. For, in endeavoring to assuage the pangs of child-birth, Simpson, though orthodox, had forgotten to reckon with Genesis iii, 16—the passage which contains God's malediction to mothers: "I will greatly multiply thy sorrow and thy conception; in sorrow thou shalt bring forth children."

The parsons got busy. Simpson was denounced as an impious meddler who sought to overthrow the divine decree of Providence. Of course, they called him an atheist, and his followers were considered imps of Beelzebub. Someone quoted Dr. Osborn's essay in which the author claims that God's curse as to painful parturition was intended to be continued as long as the world endures, which could be seen by the fact that the erect position of woman's body makes labor more tedious and difficult in her case than in the case of cows, sows and other quadrupeds which have the horizontal form.

But Scripture can be answered by Scripture, and Simpson on his part quoted Genesis ii, 21, in which it is related that when the Lord wished to take a rib from Adam in order to make Eve, he "caused a deep sleep to fall upon Adam, and he slept." This citation helped to dispel prejudice in some quarters. It was seen that God himself made use of anesthetics in difficult operations!

If we had time we would like to write a book on *Medical History from Non-Medical Sources*—we would learn much during its preparation. Nothing that any physician has written about the early days of chloroform anesthesia is more suggestive than the reaction of that magnificent idler, Charles Cavendish Fulke Greville. A man with such a name does not have to work in this world, and Charles Cavendish Fulke Greville didn't. One of the numerous dukes in his family had him appointed secretary of Jamaica, a deputy without a pedigree went over and did the work, and Charles Cavendish Fulke Greville never visited the island. His chief interest in life was the horse, and his most important quarrel was over a mare. Welcomed in palaces and stables, his knowledge of the turf brought him into association with the leading men and horses of his era; Greville himself owned such famous horseflesh as Preserve and Orlando, yet by a curious fatality, never achieved the Derby. The accident which befell his horse Alarm, while not exactly a national calamity, is considered of sufficient importance to be mentioned in the Dictionary of National Biography. It may have appeared to some of his contemporaries that this high-bred man of fashion squandered on stud the talents that would have gained applause in Parliament, but Greville courted fame in his own manner. Because of his connections and the confidence in which he was held, he knew so much about the secret history of Europe that he was able to whisper into the ear of Lord Palmerston and the Duke of Wellington. For forty years, while serving as clerk of the privy council, he kept a diary—chiefly political, but interjected with autobiography—which immediately upon its posthumous publication placed Greville among the foremost and most significant historians of the nineteenth century. In these memoirs Greville describes the operation under chloroform which he witnessed about a month after Simpson's discovery—and incidentally reveals how criminal medical ethics can be:

> I went yesterday to St. George's Hospital to see the chloroform tried. A boy two years and a half was cut for a stone. He was put to sleep for a minute; the stone was so large and the bladder so contracted, the operator could not get hold of it, and the operation lasted above twenty minutes, with repeated probings by different instruments. The chloroform was applied from time to time, and the child never exhibited the slightest sign of consciousness and it was exactly the same as operating on a dead body.
>
> A curious example was shown of what is called the etiquette of the profession. The operator (whose name I forget) could not

> extract the stone, so at last he handed the instrument to Keate, who is the finest operator possible, and he got hold of the stone. When he announced he had done so, the first man begged to have the forceps back that he might draw it out and it was transferred to him; but in taking it he let go the stone and the whole thing had to be done over again. It was accomplished, but not of course without increasing the local inflammation and endangering the life of the child. I asked Keate why, when he had got hold of the stone he did not draw it out. He said the other man's dignity would have been hurt if he had not been allowed to complete what he had begun.
>
> I have no words to express my admiration for this invention which is the greatest blessing bestowed on mankind, and the inventor of it is the greatest of benefactors whose memory ought to be venerated by countless millions for ages yet to come. All the great discoveries of science sink into insignificance when compared with this. It is a great privilege to have lived in times which saw the production of steam, of electricity, and now of ether, that is, of the development and application of them to human purposes, to the multiplication of human enjoyment and the mitigation of pain. But wonderful as are the powers and the feats of the steam and the electric telegraph, the chloroform far transcends them all in its beneficent and consolatory operations.

Yet it is impossible to predict what would have been the immediate fate of anesthetics in general, and chloroform in particular, had not Simpson unexpectedly found an almighty ally, stronger than a fort of facts, more powerful than an arsenal of arguments. Darwin had a first-rate bulldog named Huxley which showed its teeth when its gentle master was attacked, but Simpson had a mastiff that disarmed criticism and made further abuse impossible. Queen Victoria was pregnant; there was a quickening within the royal womb; the day for labor arrived; John Snow stood by her bedside; he put something on her face, and the regal mother inhaled chloroform. A few years later England's Queen conceived once more, and on the approach of parturition again availed herself of Simpson's anesthetic.

What had become of blasphemy? Where was sacrilege now? How about that passage in Genesis? Who now dare call anesthesia an invention of the devil? Did not God's right-hand favorite approve of it? Instead of a heretic Simpson became a hero; he was no longer a rebel, but a savior. Queen Victoria was grateful to the man who had eased her passage through life, for in due time the baker's son had a Sir in front of his name and a Bart. after. The doctor adopted for his coat-of-arms the rod of Æsculapius over the motto *Victo dolore!*

Had Simpson reached the years of his grandfather, he would have lived to see the fulfillment of his graduation address prophecy: "Possibly even by the concentration of electrical and other lights we may render many parts of the body, if not the whole body, sufficiently diaphanous for the inspection of the practised eye of the physician and surgeon." Overwork combined with angina pectoris—alas, the doctor's disease, again—closed his career at fifty-nine. At sundown, on May 6, 1870, he passed away in the arms of his elder brother Alexander—the beloved Sandy, who had helped him at every stage of his adventures, who had watched him grow from a barefoot lad of Bathgate village to the chief citizen of Scotland. The doors of Westminster Abbey were open to receive his dust, but Edinburgh could not give up its Simpson. The flags of the city floated at half-mast, the class-rooms of the University remained locked, the Stock Exchange closed down, business throughout the metropolis ceased, and among the countless thousands who followed the fallen chief there was no sound but sobbing, until across the silence pealed the solemn bells of St. Giles'. The body of Simpson was laid at rest in Warriston Cemetery, where five of his nine children had already preceded him, and where Lady Simpson was to follow so soon.

The animosities—including indignation at Simpson's unfair article on anesthesia in the Encyclopædia Britannica—were already fading, and Scotland felt it had buried its most celebrated son since the author of the Waverley Novels dropped his pen. If a choice is to be made between them, Sir James

Young Simpson is much to be preferred. Sir Walter Scott, descendant of border raiders, was prouder of his robber ancestry than of his literary ability. He ranked the warrior above the author, and considered it blasphemy to name a Goethe in the same breath with the Duke of Wellington. Entertained by his sovereign and the highest officials, petted by the nobility, idolized by his country, admired by all for his great talent, spending fortunes at Abbotsford, an ideal host to his many visitors, the most generous of friends, happy in the domestic circle, a kind master to his dogs and servants, Sir Walter had more than his share of the good things of life. Yet this man would go purple with rage if starving laborers protested against reduction of their miserable shillings; he who had so much, insisted that a coal-miner be denied an extra farthing; he who lived in baronial splendor on his thousand acres, demanded that the working classes be ground to the dust. A tory of the tories, the persistent foe of progress, Sir Walter was ever ready to raise a regiment to shoot the peasantry. In the final year of his life, broken and bankrupt, but still fighting hard against reform, Scott went for this purpose to the elections at Jedburgh: here the Hawick weavers, driven to desperation by excessive toil and poverty, met him with stones and shouts of "Burke Sir Walter!" Little wonder that in his last delirium, he repeated that terrible cry—"Burke Sir Walter!" The glory of Scott is equalled only by his infamy.

Simpson left incomplete what must nevertheless be regarded as one of his greatest achievements—his protest against Hospitalism. That same humanity which led him to seek a method of assuaging pain, likewise drove him to attempt to lessen hospital mortality. Appalled at the frightful statistics he collected, he remarked that "a man laid on the operating table in one of our surgical hospitals is exposed to more chances of death than the English soldier on the field of Waterloo." The introduction of anesthesia, by increasing the number and variety of operations, augmented the evil. Septic poisoning was an ever-present horror, often supervening the slightest operation;

the stench of pus filled every ward, and phagedena was rarely absent; pestilence followed in the footsteps of the most careful surgeon, and often the number of coffins carried out of a hospital corresponded to the number of patients who had entered. So Simpson tried to abolish the hospital system altogether, or urged that hospitals be constructed of iron, that they might frequently be removed, rebuilt and renovated. The suggestion does credit to his warm heart, but it indicates how he and his generation worked in darkness.

These pages have already related how Robert Liston removed the thigh of Frederick Churchill—painlessly and brilliantly under anesthesia. But we did not inquire: what made the operation necessary? The butler had fallen and injured his tibia, a discharging sinus being formed—it would have been better for him had he been on the high seas or in a desert. But he lived in a medical center, and came to the University College Hospital of London, no doubt congratulating himself that so great a surgeon as Liston would take his case. Liston probed the sinus, made an incision, put in his finger, felt the bone, and plugged the wound. The inevitable happened—fever, sweat, pulse rapid and feeble, headache, nausea, twitching, exhaustion: septicemia, requiring amputation. It was the same sickening old story all over again: the doctor, knowing nothing of infections, had unknowingly infected his patient. The hand of Liston was cunning—but unsterilized. Churchill's limb was sacrificed to the ignorance of the age, and Hospitalism claimed another victim.

In the latter years of his life, the answer to Simpson's prayer came from a younger professor in the university of Edinburgh, but Simpson did not perceive the light. He opposed his teaching, and when this colleague came down from Edinburgh to London to demonstrate the new principles, he found himself unwelcome to surgeons, students and nurses; resentful of a strange method, hating his carbolic spray, and shocked at his sacrilege of changing dressings on the Sabbath, the sisters of St. John lined up in solid opposition to this man, and it was in the midst of innumerable insults and stiff white caps held high in air, that Joseph Lister established antiseptic surgery.

The writer of these lines has stood in homage before Simpson's statue in Edinburgh, and before his bust in Westminster Abbey, and on each occasion thought: It was this man's glory to be a principal worker for the mastery of pain and to realize the need of the conquest of sepsis, though in the latter instance he did not see clearly. Anesthesia and Antisepsis are two of the chief blessings of modern medicine, and it was not vouchsafed to any one man to lay them both upon the altar of mankind. But Simpson gave chloroform anesthesia to the world, and this is enough for immortality.

(1806-1875)

GUILLAUME-BENJAMIN-AMANT DUCHENNE

A scientific journal fails in its duty of gratitude if it does not address a sympathetic farewell to those of its collaborators whom death carried away from mutual labor.

When a writer has taken his place in the first rank of workers of his generation, and when imposing discoveries are attached to his name, it is no longer a sign of affection, it is an act of justice to render to the memory of such a savant the homage which is due him.

Duchenne of Boulogne was one of ours; the greater part of his memoirs were published in the Archives, and his books have often contained but the development of those ideas of which he here had deposited the seed; it is the least that we can do if we recall within our Archives his claims to celebrity already conceded, and which posterity will confirm.

C. Lasègue and J. Straus: *Archives générales de médecine,* 1875.

XXII

GUILLAUME-BENJAMIN-AMANT DUCHENNE

I

At the outposts of human knowledge, the first mind we meet is Thales—chief of the Seven Sages of Greece. We know little of the life of Thales of Miletus, except that on a narrow strip of land by the Ægean Sea, he became the father of science. By drawing angles and circles which he activated with theorems, he created geometry; by measuring the height of the pyramids by their shadows, he laid the base of physics; by predicting with accuracy an eclipse of the sun, he founded astronomy; by declaring that water is the origin of all things, he established Greek philosophy—Aristotle calls Thales the man who made the first attempt to establish, without myths, a physical Beginning. When Thales rubbed a piece of fossil resin and observed the amber attracting bits of cloth and feathers, he opened the story of electricity—and to this day, children repeat the experiment of the great Ionian.

That was about 600 B. C., and for the next two thousand and two hundred years, there was slight advance in our knowledge of that imponderable invisible agent of nature whose conquest is the romance of science. By that time, Greece had perished—though its legacy to mankind is imperishable. A woman sat on England's throne, and among her subjects was her physician, William Gilbert of Colchester, the first of the English Copernicans. It is often said that Elizabeth took a keen interest in Gilbert's experiments—but according to the banalities of biographers, all monarchs were the patron-saints of science. It is fully attested that an astrologer who claimed to hold converse with spirits was asked to calculate a propitious day for Her Majesty's coronation, and Elizabeth displayed more curiosity in the magic mirror of this John Dee than in Gilbert's comparisons of magnetic force to a living force.

When a waxen image of Elizabeth, with a pin stuck through its breast, was found in Lincoln's Inn Fields, the terror-stricken queen turned for succor, not to her physician, but to her astrologer. Dee had an extensive library, possessed considerable book-learning, and proved himself an able interpreter of Euclid, yet in spite of the constant tricks and impostures he practiced upon others, he was himself so credulous that he was completely victimized by the younger but greater scoundrel, Edward Kelly—who never removed his black skull cap because he had lost both his ears in the pillory at Lancaster. Dee loved his second wife, and was overwhelmed when Kelly calmly informed him that the spirits insisted they share their wives. He could not, however, disobey the divine command, and with his own hand wrote . . . "for indissoluble and inviolable unities, charity and friendship keeping between us four, and all things between us to be common. . . ." Their crystal globe must have been awry in its circumference, for soon after these necromancers had signed the oath of eternal amity they quarreled so violently, abetted by their wives-in-common, that they parted forever.

Old John Dee carried a shew-stone which he asserted was the personal gift of an angel, he dressed in an artist's gown with hanging sleeves, he realized the value of his long beard as white as milk, and he received numerous visits from his sovereign, for his legerdemain was more congenial to her Tudor intellect than the sober investigations of William Gilbert.

In 1600—the year in which the Italian Copernican, Giordano Bruno, was marched to the stake in the Campo dei Fiori—Gilbert published *De magnete, magnetisque corporibus, et de magno magnete tellure,* which contains the first mention of the word electricity. Summing up the current knowledge of his time in regard to electricity and magnetism, in the manner of modern scientific treatises; showing how little was really founded on demonstrated fact, and how much on inherited superstition; exposing the fables of magnetic mountains which disturbed ships at sea; discarding a host of other wonder-tales, picturesque but untrue; scorning the men who fill out bulky volumes by copying pages upon pages, yet know nothing of their own experience; putting down in his book only what he had himself many times explored, performed and repeated; inventing instruments, including the electrical needle, yet capable of such poetic phrases as "Amber holds flies, ants, and other small creatures shining in eternal sepulchres"; conceiving the globe of the earth as a vast spherical magnet; illustrating his experiments with diagrams; never deviating from a rigid adherence to the modern scientific methods of investigation and experimentation; applying the principles of electric and magnetic phenomena to navigation and other practical purposes; declaring again and again that not intuition and inner consciousness, but accurate observation and careful experimentation are the only foundations of true science, Gilbert produced the first systematic classic of physics; like all pioneers, he had his Robert Norman, but alone, he virtually brought forth, by the experimental and inductive methods, the sciences of electricity and magnetism.

Before 1600, these mighty twin forces still slumbered in the womb of darkness; they were aroused, stirred to activity, and modernized by the hand of Gilbert.

The author of *On the Magnet, Magnetic Bodies and the Great Magnet, the Earth,* never married, and left no heir to mankind except an immortal folio of 240 pages; he died three years after its publication, presumably of plague; he bequeathed his library, globes, instruments and minerals to the Royal College of Physicians, where they were destroyed by the Great Fire. But neither plague nor flame nor the forgetful centuries can obliterate the landmarks erected on the highway of science by William Gilbert. "Gilbert shall live till lodestones cease to draw": Dryden's prophecy is one of the commonplaces of quotation. The praise of Gilbert's greatest contemporaries, Galileo and Bacon, has found an echo in our own day. On the tercentenary of the publication of *De magnete,* the members of the Gilbert Club translated it from the Latin into English, reproducing the folio's format, and adding valuable notes about the work of the First Electrician.

Gilbert's work opened various currents, and after him the story of electricity flows through ever-widening channels. A piece of sulphur, a silk stocking, a kite among the clouds, the twitching legs of a frog—these were sufficient to create epochs. The invention of the simple Leyden jar was as momentous as the discovery of a continent.

The story goes on from Newton and Boyle to Stephen Gray—a poor brother of the Charterhouse, where he conducted priceless researches; from Franklin to Cavendish and Priestley and Wollaston and John Hunter; from Volta's pile to Galvani's arc and Coulomb's torsion balance; it proceeds from Davy to Faraday, and expands from Oersted and Ohm and Ampère; it broadens in scope with Kelvin and Clerk-Maxwell and Helmholtz; it reaches a culminating point with Helmholtz's favorite pupil, Heinrich Hertz, who at thirty found the waves which were to give us wireless telegraphy. Helmholtz himself reported this work at the Berlin Academy. "The impression will never be forgotten by any one," wrote W. von Bezold. "The most intense and purest joy shone in the countenance of the great master, who explained in eloquent words and with the freshness of youth, the importance and influence of this fundamental work."

There is a force even more mysterious than electricity, and it is death. On the first day of the year, 1894, Heinrich Hertz, not yet thirty-seven years of age, passed from this earth. His old master bowed his head. "In classical times," said Helmholtz, "his death would have been regarded as a sacrifice to the envy of the gods."

Even death cannot stop the story of electricity, and it continues with Bequerel, Roentgen and the Curies, spreads with Tesla, Marconi and Edison, goes forward with Millikan and Michelson, reaches new ground with Einstein, and almost daily enlarges the frontiers of human understanding.

II

Sun-tide and moon-tide make the spring-tide of Boulogne, the green-blue basin of Boulogne. Ships, herring-filled and mackerel-laden, riding to the rhythm of the harbor of Boulogne. There is no color like the color of moving water, there is no music like the music of flowing water. Boat-builders and fishermen of Boulogne, with the salt-spray on their lips and the sea's mystery in their veins—there are no men like the men who live on water. Sea-grass floating by beneath the star-silence, drifting through the channels of Boulogne, how many generations of Duchennes have you known?

Jean Duchenne and his wife Denise had four sons in Boulogne; for two hundred years the Duchennes had followed the tides, and once again the father called his children to the sea. The second son—he who was named Guillaume-Benjamin-Amant—looked the sailor, and that thickset figure seemed at home among the rigging; the fishing-smacks came in and out of Boulogne, but destiny had set Guillaume-Benjamin-Amant Duchenne upon a voyage across unmapped seas and never-reached ports.

The medical school of Paris, with a faculty then famous, now historic. . . . Duchenne, an unobtrusive and undistinguished student, graduating quietly in 1831 with a forgotten thesis on burns. . . . Bichat was the favorite of Desault; Bretonneau was as a father to Trousseau; Laennec found a medical brother in Bayle; Louis was much attached to young Jackson; Magendie helped Claude Bernard, who in his turn rendered service to Paul Bert. But Duchenne made no impression upon his teachers. An assistantship was not offered, no one requested him to remain, and it is doubtful if he could have obtained an appointment for spreading mercurial salve at the Hôpital du Midi—the great venereal realm of Ricord, known as the worst-conducted and dirtiest hospital in Paris.

Duchenne returned to Boulogne-sur-Mer, married Barbe Boutroy, and became a father. The years passed, his wife died, and he continued to practice medicine among the fisherfolk. His sea-dreams have been lost, for only poets tell these things: one who knew Boulogne in his youth, and ever bore within him the disease of life, wrote these words of water:

O water whispering
Still through the dark into mine ears—
As with mine eyes, is it not now with hers?—
Mine eyes that add to thy cold spring,
Wan water, wandering water weltering,
This hidden tide of tears.

In 1842, after eleven years in Boulogne, Duchenne came back to Paris. The minister of instruction did not send for him and no director of clinics welcomed the unknown doctor, who had certain ideas he wanted to work out. Some time previously, Magendie and Sarlandière had experimented with electropuncture—and the chief result of these experiments was their effect on Duchenne. It appears that Magendie was neither a gentleman nor a scholar, but it is remarkable how frequently he vitalized, actually galvanized, the work of others. We could like this man for his frankness, his unassuming simplicity, his energy and keen intelligence, but his inhumanity to animals makes us draw back. Magendie's foramen still remains above the calamus scriptorius, Magendie's law will ever stand in physiology, and were we not confused by the cries of dogs tortured in experiments that were often aimless and useless, we could quote with better grace the words of Brunton: "Magendie not only laid the foundation-stone of modern pharmacology, but left behind him works which may still serve as a model for investigators." We do not know which is worse —the anti-vivisectionist who holds all experimenters in abhorrence, or the experimenter who looks with scorn on all who feel compassion for animals. Nature, the blundering giant, has made it impossible for man to secure certain knowledge except by inflicting pain upon the lower creatures.

Every day Duchenne visited hospitals, ransacking case-reports, questioning and arguing with the physicians, following patients from institution to institution. Now, Paris may be unconventional on her boulevards, but her hospital etiquette is rigid. Duchenne was not a member of any staff—what was he doing on exclusive territory? At first the attendants laughed at him and his provincial accent, later they regarded him as a nuisance and a crank. He seemed to have infinite leisure, and wanted to know what no one else knew or cared about. This sea-captain's son with the broad shoulders should be on a sloop, instead of disturbing the clinics. Evidently he had no practice of his own, else how could he have found the time to spend so many days upon a single case, even tracking the patients from house to house? His coming came to be dreaded, and he received rough treatment. Not only internes and chiefs, but "sensitive students" objected to his unofficial presence. As well insult a brass statue! Duchenne's bronzed and bearded face did not disappear from the clinics. In pursuit of his studies, he was clothed in armor which no rebuff could penetrate. Every day Duchenne came to the hospitals as a volunteer worker, gathering material which the others discarded.

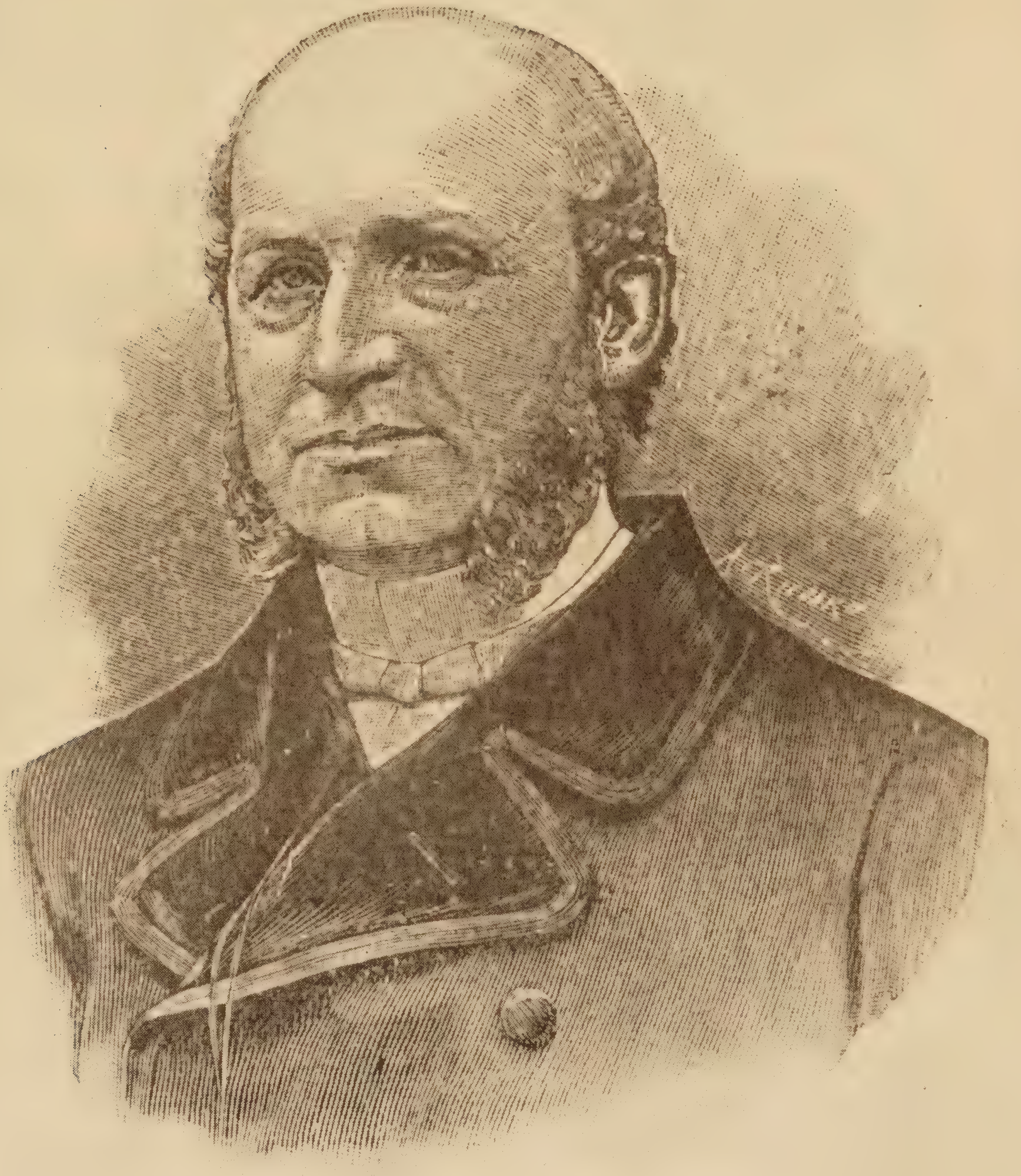
"Persist," said the last of the Victorians, "if thou wouldst truly reach thine ends." Too much in earnest to be courteous, without diplomacy, handicapped by an awkward manner and a Boulognese tongue, Duchenne persisted. He achieved many enemies, but as he could not be rebuked he arrived at the stage where he was tolerated at the hospitals, and then welcomed. His naïve interest in the cases, his extraordinary knowledge of diagnosis and treatment, and his profound conviction that no one understood neurology except himself, made him physician-at-large to the Paris hospitals. There came a time when there was no more familiar sound in the wards than the characteristically explosive *Bon!* of Duchenne—when he had solved a problem.

Duchenne's hard work resulted in recognition. Patients demanded his services; successful practitioners called him in consultation; learned societies elected him to membership; his books passed through several editions, and were translated; he had contact with Charcot and Ludwig; de la Rive came to his laboratory; Becquerel recognized his existence by disputing with him about magneto-faradic instruments; Jamin watched his electrophysiological experiments; Le Roux spoke of the value of his apparatus; Aran said, "I owe a thousand thanks to Duchenne"; Trousseau, standing at the head of the French profession, popularized his ideas by tongue and pen; the authors of *Gunshot Wounds and Other Injuries of the Nerves*—S. Weir Mitchell, George R. Morehouse, and W. W. Keen—wrote: "The only important means in the treatment of paralysis arising from default of innervation, is faradization by the method of M. Duchenne. . . . In a word, we cannot too strongly repeat that, until faradization has been used, no limb, however completely paralyzed, should be abandoned as hopeless."

No man in Paris knew the hospitals better than Duchenne, yet he never received a hospital appointment nor filled an academic chair. His method did not permit him to be fettered by official positions, and no single school or hospital would have sufficed for his researches—he found it necessary to roam through the hospitals at will, and even to visit those of other countries. Considering Duchenne's temperament, this method was essential, but of course Gilbert Breschet could not have functioned that way. The disadvantage was that Duchenne did not have control of the autopsies, but when accused of neglecting pathological anatomy, he defended himself nobly:

> Those who have made these reproaches were doubtless ignorant of the fact that I have merely been permitted to glean, as it were, in our hospitals, and that if I have been able to exist in a

Un portrait de Duchenne de Boulogne



scientific sense, it is only because I have been fortunate enough to collect, by searching over the numerous clinics of our hospitals, certain clinical facts which have been, I will not say despised, but, rather, which have escaped notice. Those who have criticised me should know also that when I have happened to discover a morbid species not hitherto described, I have had no control over the subjects upon which, when living, my clinical observations were made. I should have had, it is true, the right of completing my researches by anatomical investigation if I had been a hospital physician. But then, riveted as it were to my own wards, I should not have been able to do the work of a searcher which I set myself to do, and I am sure that my chief works (among others those on progressive muscular atrophy, atrophic paralysis of childhood, progressive locomotor ataxy, glosso-labio laryngeal paralysis, and pseudo-hypertrophic paralysis) would never have seen the light. To accomplish these, in short, a field of observation more vast, and extending to all the hospitals of Paris, was necessary. If then I have renounced, and still renounce, the honour of an official position, it is because I wish to give myself up freely and entirely to my irresistible taste for physiological and pathological researches. Ought it to be a subject of reproach to me that I have disinterestedly followed science solely for the love of it?

Having benefited some deaf persons by faradization, he was besieged by the deaf and dumb—frantic for relief, and ready to believe in miracles. "Willingly or otherwise," said Duchenne, "I was compelled to continue my experiments, although they were but little in harmony with my tastes." Duchenne's experience with the congenital deaf-mute Raymond is one of the most interesting cases in the annals of otology: Raymond was congenitally deaf; he did not have convulsions, but he could hear neither the loudest cries, nor the ringing of a powerful alarm near his pillow, nor the diapason when placed on the cranial wall. He perceived only explosive sounds, and the prognosis of Menière was bad. Duchenne himself believed in the incurableness of deaf-mutism, and disliked experimenting under such circumstances; it was only to please the child's parents that he undertook the case.

Without hope he applied his instruments, but the results surpassed all expectations. At the fourth sitting, the child manifested that he perceived sounds—and he began to repeat what he heard. "Nothing," says Duchenne, "can describe the emotions of the mother as she thus made her child for the first time hear the human voice, to which she had been taught to believe that he was incurably deaf. And with what mingled joy and ardor she proceeded to give her first lesson to the newly born speech and hearing." In a short time the hitherto voiceless Raymond heard well and was able to pronounce *papa, maman, bonbon.* After the suspension of the treatment, the physician did not see his little patient for a considerable time, but when they met again, the boy—who was very intelligent—said clearly, "Bonjour, monsieur le docteur Duchenne de Boulogne."

Duchenne's medical life was crowded with interesting cases. He became the talk of the town when he drew from his bed a patient regarded as absolutely paraplegic, and loaded him with the weight of a full-grown man, which the supposed paralytic bore without flinching. In a former century, this would have warranted an accusation of witchcraft. Duchenne reported the following case in his Localized Electrization:

> A pastrycook's boy, fifteen years old, of eccentric character, had endeavored to drown some imaginary troubles in drink; and had the notion, in his intoxication, to try to asphyxiate himself by creeping, during the night, into a sort of hole situated over his master's oven, where he remained to sleep himself sober. The next morning, the men who went to light the fire saw one of his feet, and drew him, seemingly lifeless, from the place where he had passed the night. Living in the same house, I was able to try, a few minutes later, to recall him to life by faradization. His face was blue, there was no respiration, a mirror held before his lips remained untarnished, no pulse could be felt, the action of the heart was not discoverable by the hand, but on auscultation, feeble valvular sounds were heard. While I made this examination my induction apparatus had been got ready by my son, who assisted

me. I was about to excite artificial respiration through the phrenic nerves, when I saw that the rheophores had been forgotten. The danger being very urgent, I instantly applied the metallic extremity of one of the conductors of the induced current of my instrument (at its maximum, and with rapid intermissions) over the left nipple, and moved the other conductor about over the apex of the heart. After a few seconds, slow and weak respiratory movements appeared, and increased progressively in frequency and depth; and, at the end of a minute, the pulse could be felt. Soon afterwards, the face assumed a slight expression of pain. In a few minutes the patient uttered a faint groan, and moved first the arms and then the trunk, as if to remove the conductors from his chest. Then he gave a loud cry, kicking with his feet at the people surrounding him, and began to reply to the questions that were asked. In five or six minutes the respiration and circulation were re-established, the color of the face was natural, and the intelligence had returned.

He appeared to be saved. However, I ordered sinapisms to be applied to the limbs and the precordial region, and warned his master that he might fall back into a state of coma, from the toxic influence of the carbonic oxide. In fact, a few minutes after the suspension of the cutaneous faradization, he no longer replied to questions; his respiration slackened, at times he seemed as if he forgot to breathe; his face became discolored and his lips blanched; then the breathing became stertorous; he could not feel when pinched; in a word, he was asphyxiated afresh. He was quickly restored by cutaneous faradization of the precordial region, applied this time less severely, as it was quickly and acutely felt. It was continued by my son for about twelve minutes, until the respiration, circulation, and intellectual faculties, were all completely restored, and he could stand erect and walk.

Believing this cure to be only apparent, I ordered his removal to the Hôtel Dieu, to the wards of Professor Trousseau, where I shortly followed him. Foreseeing that the carbonic oxide would continue its poisonous action, and produce a return of coma, I had placed sinapisms upon his legs, and had directed the person who conducted him not to let him sleep. An hour later I found him in the hospital, in a state of coma, into which he had fallen on the way, in spite of the efforts of his guide, who had in vain slapped him to try to keep him awake. It was necessary to return to the electro-cutaneous excitation of the precordial region, and to repeat it several times during the day, as well as to apply sinapisms over the body, before we were entirely freed, towards the evening, from the tendency to consecutive coma, due to the poisonous influence of the carbonic oxide.

The life of the pastrycook's boy was saved, but the memory of this case is melancholy, because of the reference to Duchenne's son. There was a beautiful relationship between Duchenne and his son, Emile-Guillaume-Maxime, known as Duchenne fils de Boulogne. The date of his birth has not been recorded, but in 1864 he graduated in medicine at Montpellier, with a thesis—De la paralysie atrophique graisseuse de l'enfance—plainly showing his father's influence. The two Duchennes were much devoted to each other, and became associated in practice—until dementia præcox transferred the gifted boy from the clinics to the insane asylum. Duchenne, master of neurology, was compelled to stand by, helplessly and hopelessly, as many physicians have done before and since, and watch his only son perish in unknown darkness. In this connection, Americans think of the tragedy which obscured the soul of Bayard Holmes, most of whose writings deal with this terror of adolescence which robbed him of a brilliant and beloved son. The psychoanalytic explanation—that in dementia præcox the libido is turned back upon the ego, and this reflected turning back is the source of the megalomania—helps us not at all. Not in our generation will we see the curse of dementia præcox removed from the human race.

Duchenne wrote much, and at times used his pen as if it were a galvano-cautery: in extenuation, it should be remembered that those were the days when the most illustrious French surgeons, Dupuytren, Lisfranc, Velpeau, called one another bastards and bandits. Duchenne was not personal; he was simply so interested in his subject that he spoke of the myths imagined by Sir Charles Bell, he asserted Ludwig Türck could not diagnose locomotor ataxia, and he applied a continuous current of sarcasm to Remak.

"M. Duchenne," said Remak, "appears to be ignorant of the difference which exists between a constant and inconstant chain; although he lives in Paris, near M. Becquerel, the celebrated inventor of constant chains." Elsewhere Remak wrote: "Whoever has seen the skill and confidence with which Duchenne throws the great muscles into contraction could almost complain of his intention to preserve his secret." And Duchenne answered, bitingly: "During several hours that the séance lasted"—at which Professors Richter of Dresden, Jaksch of Prague, Hebra of Vienna, and other German scientists were present—"Remak saw me produce, in succession, contraction of a large number of muscles *en masse,* and of separate fasciculi, the former by exciting their nervous trunks, the latter by placing the rheophores upon them, beyond the points of immersion of the nerves. This great critic, however, who has witnessed the results that I obtained, and has made them the subject of eulogy, obtained no glimpse of the particular methods that allowed me to obtain them! With whom is the blame? Did I trust too much to his anatomical knowledge? Had microscopic anatomy caused him to forget that which can be seen with the naked eye? Such seems to be the only solution of the enigma." In this manner, many of the pages of Duchenne and Remak—two workers whose discoveries are of permanent value to science—are marred because each insisted that the other was an ignoramus. Despite this long drawn-out Franco-German battle, Duchenne's disease, Duchenne's syndrome, and Duchenne's paralysis survive in our nomenclature, along with Remak's fibres, Remak's ganglia, and Remak's plexus. It is said that Duchenne was too original to be much of a reader, and had he been more familiar with Romberg and Erb, he would have avoided unnecessary controversy. Nevertheless, in his work we find frequent references to other investigators, usually with historical retrospects and bibliography. He is full of praise for Claude Bernard and after confessing, "Claude Bernard has shown that section of the chorda tympani dries up the secretion of the submaxillary gland, while my experiments, although repeated a hundred times, had not made me even suspect the existence of this fact," he pays a characteristic tribute to his great contemporary. The following gives us an insight into Duchenne's method:

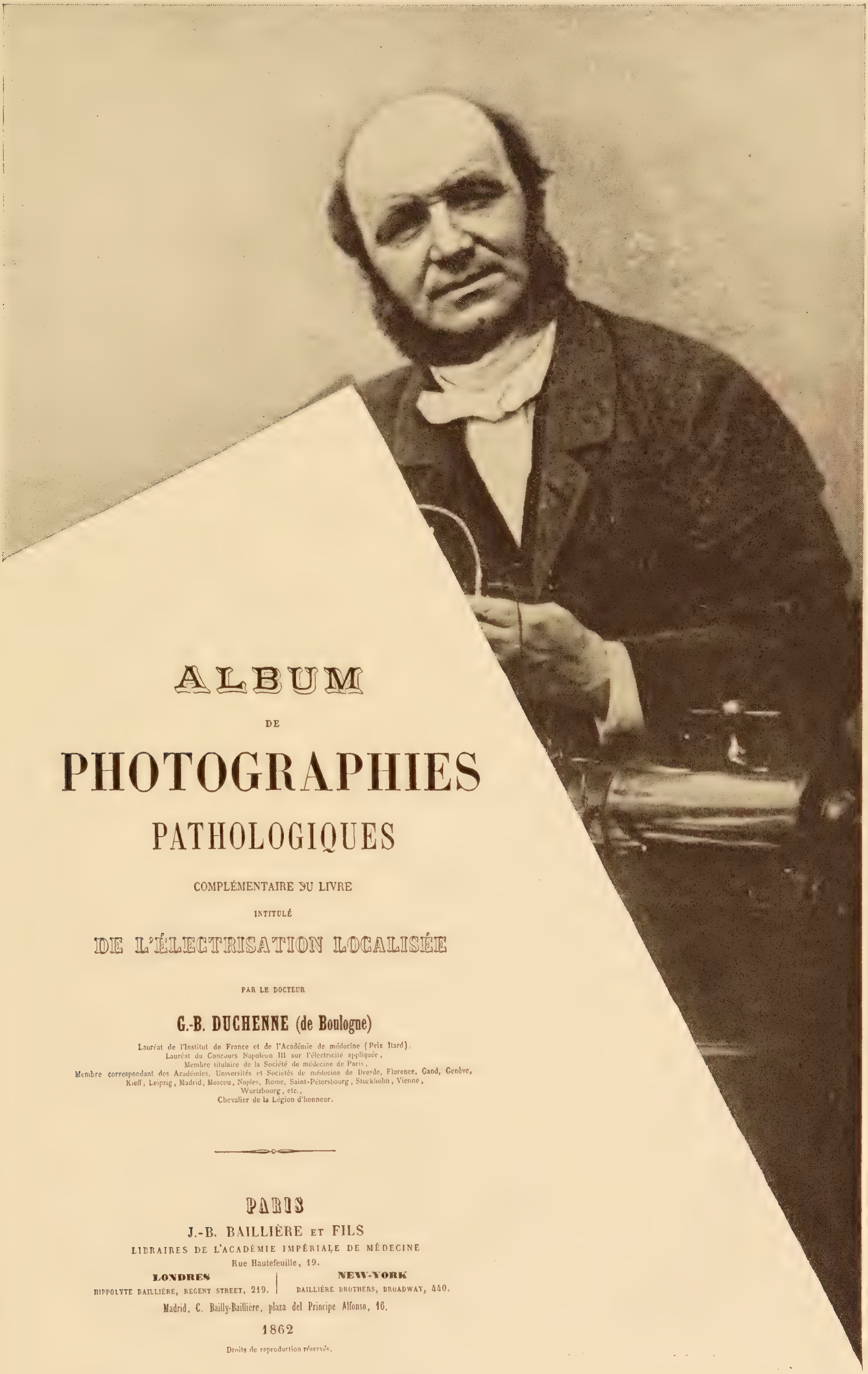
> Contrary to ordinary custom I have not prefaced my work on locomotor ataxy with any historical considerations, and I owe some explanation of it to my readers. When one wishes to devote oneself to the observation of the signs of disease and their nature independently of all external influence it is necessary, I think, to guard against filling one's mind with the work of others who have dealt with the matter in hand. This is a principle from which I have never deviated, always postponing till the end my bibliographical researches, and never mentioning the work of others until I have given my own. Had I done otherwise I should always, as it were, have been looking at my facts with another man's spectacles, and this must have hindered my own observations.

Once again we cite Claude Bernard—his remark to his friend Gambetta: "It is that which we do know which is the great hindrance to our learning that which we do not know." The books of learned men have often been stumbling blocks in the path of medical progress. Stahl was a scholar, and because of his erudition he was able to do more harm to science than a hundred untutored quacks: by his fiction of phlogiston, he confused chemistry for a century; as the father of vitalism, and the protagonist of the doctrine that organic phenomena are not governed by chemico-physical laws, but by the laws of the "sensitive soul" he trammeled biology with a farrago of mysticism from which it is not yet wholly free; and by his claim that all varieties of insanity resulted from impious perversions of morality, he was responsible for much brutality in psychiatry. Knowledge, in the possession of a mind that cannot interpret it without prejudice, is a dangerous weapon. Ludwig Choulant, recently revived by Mortimer Frank, was one of the most learned physicians of the nineteenth century: he produced an amazing list of translations, bibliographies, chronologies, medico-historical essays, editions of classics, monographs and text-books. As a practising physician, professor and director of the Dresden Medico-chirurugical Academy, he had the opportunity to remain well-balanced and forward-looking. Yet even his fine aphorism—"The history of a science is the palladium of its freedom; it prevents it from being tyrannized over by narrow, bigoted viewpoints"—did not save him from the dogmatism of a Jacobus Sylvius or a Georg Ernst Stahl. The last of the great symptomatologists, Choulant was expert in questioning patients about their symptoms and in observing the external manifestations of disease, but he opposed vehemently the advances in physical diagnosis, chemical and microscopical findings, and pathologico-anatomical methods. Thus the savant Choulant, in the midst of innumerable folios, stands as an obstructionist in science, while Duchenne, rheostat in hand, emerges as a pathfinder.

It takes a long time before an idea in medicine filters throughout the profession: there are important suggestions in Hippocrates still awaiting application. Duchenne and others knew of the causal relationship of lues to locomotor ataxia, but long after his death, the profession still blundered. The fifth and concluding volume of William Pepper's System of Medicine was devoted wholly to nervous diseases, the most frequent malady of the spinal cord being from the pen of E. C. Spitzka, one of the acutest and best-informed American neurologists of the day. In the first place, Spitzka showed himself adrift from the facts by regarding tabes dorsalis and locomotor ataxia as separate entities; he floundered in deep water by scornfully rejecting Erb's statement, that "tabes dorsalis is probably a syphilitic disease whose outbreak is determined by certain accessory provocations"; and under etiology he showed himself entirely at sea, by listing as among the causes of tabes: the crime of Onan, coitus in the upright position, worry and psychic jars, poisoning by illuminating gas, the taking of absinthe, the eating of ergot, the shock of the Ashtabula disaster, falling from a chair while trying to keep a row of books from coming down, and—most important and most indisputable of all—wet feet. Alas, for American neurology in 1886! We have dilated on the evils of too much reading, but in this instance it would have been better for our profession, and for their patients, if Spitzka and his colleagues had read and believed the works of Duchenne.

In Duchenne's *De l'Electrisation Localisée,* published in 1855, he laid down the essentials and fundamentals of electrotherapy: more than ten years later, A. D. Rockwell graduated in medicine, and in looking back to that period, stated: "During all my medical training I do not recall that electricity was ever mentioned in connection with therapeutics or even surgery." He was introduced to curative electricity by an old irregular—Doctor (by courtesy) William Miller—whose electrical and intellectual equipment were equally meager, but who possessed the rarer virtues of honest enthusiasm and a good heart. When Rockwell first broached the subject to the leaders of the profession, Austin Flint said, "I cannot lend my name to any such project"; Willard Parker said, "It isn't worth your while—any old woman can apply electricity"; E. R. Squibb, the noted drug manufacturer, did not exactly say anything, but he asked, "Are these men regular?"—and it was the doughty Squibb who prevented young Rockwell from reading a paper on the subject before the Kings County Medical Society. Stories of the early days of electrotherapy in America, with reminiscences of the dynamic G. M. Beard, will be found in Rockwell's *Rambling Recollections.*

Even the friends of Duchenne admitted his prolixity, but in this connection two factors must be remembered: in the first place, there was more time in those days; and secondly, it was customary for the French physicians of that period to describe their cases in great detail. Velpeau, the blacksmith's son, rose to surgical eminence against the obstacles imposed by utter



ALBUM
DE
PHOTOGRAPHIES
PATHOLOGIQUES

COMPLÉMENTAIRE DU LIVRE
INTITULÉ
DE L'ÉLECTRISATION LOCALISÉE

PAR LE DOCTEUR

G.-B. DUCHENNE (de Boulogne)

Lauréat de l'Institut de France et de l'Académie de médecine (Prix Itard),
Lauréat du Concours Napoléon III sur l'électricité appliquée,
Membre titulaire de la Société de médecine de Paris,
Membre correspondant des Académies, Universités et Sociétés de médecine de Dresde, Florence, Gand, Genève,
Kieff, Leipzig, Madrid, Moscou, Naples, Rome, Saint-Pétersbourg, Stockholm, Vienne,
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poverty and bitter enmity, yet by the time he reached his mid-forties he had sent to press over twenty-five thousand pages. Compared with this ceaseless output, Duchenne's bibliography of some fifty titles seems moderate, even if he did not always avoid circumlocution.

The man's honesty is obvious on every page, whether he is quarreling with the German neurologists, or reverently correcting a line upon the forehead of Laocoon, or carrying forward Borelli's work on the diaphragm and Charles Bell's work on the hand, or grandly philosophizing, "If it were possible to master the electrical current, especially in the face, we could, like nature herself, paint upon the human visage the expressive traces of the emotions of the soul."

Out of the numerous writings of Duchenne, three works stand forth as masterpieces in medicine—*On Localized Electrization* (1855), *The Mechanism of the Human Countenance* (1862), and *The Physiology of Movements* (1867). The first, by applying electricity to pathology, created the science of electrotherapy; the second, by its electrophysiological analysis of physiognomy, explained the human face; and the third, with its electromuscular observations and experiments, is the organon of myology. The English reader will gain a good conception of Duchenne from the brochure on nervous deafness, translated by Laurence Turnbull (1863) ; from the first portion of the treatise on localized electrization in the translation of Herbert Tibbitts (1871) ; and from the volume of clinical selections, ably edited for the New Sydenham Society by George Vivian Poore (1883).

If the writings of Duchenne of Boulogne, like those of Philagrius of Thessalonica, were lost, his name would survive, not only in its various eponyms, but because he has been embalmed for immortality by the central figure of modern science. In his *Expression of the Emotions in Man and Animals* (1872), Charles Darwin frequently quotes Duchenne—"and I could not quote a better authority"—uses many of his facts and photographs, and renders him this unforgettable tribute:

In 1862 Dr. Duchenne published two editions, in folio and octavo, of his "Mécanisme de la Physionomie Humaine," in which he analyses by means of electricity, and illustrates by magnificent photographs, the movements of the facial muscles. He has generously permitted me to copy as many of his photographs as I desired. His works have been spoken lightly of, or quite passed over, by some of his countrymen. It is possible that Dr. Duchenne may have exaggerated the importance of the contraction of single muscles in giving expression; for, owing to the intimate manner in which the muscles are connected, as may be seen in Henle's anatomical drawings—the best I believe ever published—it is difficult to believe in their separate action. Nevertheless, it is manifest that Dr. Duchenne clearly apprehended this and other sources of error, and as it is known that he was eminently successful in elucidating the physiology of the muscles of the hand by the aid of electricity, it is probable that he is generally in the right about the muscles of the face. In my opinion, Dr. Duchenne has greatly advanced the subject by his treatment of it. No one has more carefully studied the contraction of each separate muscle, and the consequent furrows produced on the skin. He has also, and this is a very important service, shown which muscles are least under the separate control of the will.

In evaluating Duchenne's services, the first award must be made for his refusal to accept any statement until he had tested it. Time and time again, the foremost scientists have led us astray in the very fields where we expected their light to shine brightest. Karl Ernst von Baer, the discoverer of the human ovum, author of the germ-layer theory, and creator of comparative embryology, is honored as the father of modern embryology, yet extraordinary as it seems—after it had been proved by others—this master of his subject stubbornly maintained that the spermatozoon has no connection with fertilization. It remained for lesser embryologists to detect and demonstrate the germ-cell uniting with von Baer's egg. It reminds us of Aristotle whose brain gave birth to the biologic sciences, and yet denied that the brain is the source of intelligence.

It was an important day for medicine when Duchenne placed two wet electrodes on the moistened epidermis, and found that the current ignored the skin but localized its action on the muscles and subjacent nerves. With this key he opened a new door to neurology. Instead of the painful and dangerous method of electropuncture, he taught the physician how to limit and control electrical excitation without pricking, incising and damaging the patient's skin.

He described and named one of the best-known of the idiopathic atrophies—pseudohypertrophic paralysis of Duchenne. Of this awful and incurable disease of childhood we know no etiological factors except heredity: the mother, though herself unaffected, passes the affliction to her sons. With strange incongruity, the muscles enlarge while weakness increases; then wasting ensues, and the boy is unable to stand; the knee-jerks are abolished, and only the moving hands are left to protest against an inexplicable fate. There is no treatment, and slowly and surely, complete paralysis ends the miserable picture. How anyone can look through a Textbook of Pediatrics, and contemplate the cruel and senseless tortures especially reserved for childhood—and then believe all that we are asked to believe about the Universal Beneficence, is something we fail to fathom.

Duchenne's name is associated with a more widespread disease of children—acute anterior poliomyelitis. One of its synonyms is acute fatty atrophic paralysis of Duchenne; his son also published investigations of this disease. Duchenne was among the first to point out that in infantile paralysis the locomotor system was wrecked by definite lesions in the anterior horns of the spinal cord. He discovered the relation which the faradic current bears to the affected muscles, devised many artificial muscles to supplement the paralyzed natural ones, and laid down the prognostic law, "All the cases of infantile paralysis which I have seen where the faradic contractility was diminished but not lost, and which could be treated by faradic electricity within two years after the onset of the paralysis, have completely recovered."

Either our hands are less skillful or less faithful than those of Duchenne, for we cannot accomplish with the electric current all that he claimed to do. Electricity has won her greatest victories, not in medicine, but in industry. Moreover, infantile spinal paralysis is more virulent now than in Duchenne's time. As late as 1906, Emmett Holt published the statement that poliomyelitis is unaccompanied by danger to life: the next year, in the summer and the sunshine, the invisible enemy approached and left behind it not only atrophied legs and twisted backs, but plenty of young corpses. About ten years later it broke forth with such unexampled fury as to become a great American menace—it was the Children's Plague, and there is nothing more pitiful than the impotence of Medicine when an unchecked epidemic invades the nursery. The encouraging voice of Duchenne was not heard in 1916.

The wasting palsy of adult males—progressive spinal muscular atrophy—was first accurately described in Duchenne's *Atrophie Musculaire avec Transformation Graisseuse* (1849), followed by the researches of Aran (1850), and is known as Duchenne-Aran's Disease. This horrible malady of unknown origin begins in the hands, and when the muscles of the ball of the thumb become useless, followed by atrophy of the interossei and lumbricales, we see the characteristic bird-claw hand known as the *main en griffe* of Duchenne. As Duchenne, in connection with infantile spinal paralysis described a subacute form in adults—*paralysie générale spinal antérieure subaiguë* of Duchenne—he found in connection with this adult palsy an early variety commencing in the facial muscles and known as Duchenne's hereditary infantile atrophy.

If a man begins to find it difficult to pronounce those letters of the alphabet requiring the use of the tongue for their formation, he carries his doom within him. There is no magic in the materia medica that can frighten bulbar palsy. It is never in haste, its advance is indeed slow, but only death can save its victim from its inexorable arrival. One by one the dreaded symptoms develop until he is unable to talk, or close his mouth, or swallow his food, or expectorate his saliva, or prevent its constant drooling—and all the time the mind remains clear so the patient can watch the disgusting part he plays in his own tragedy. The first complete clinical description of glossolabiolaryngeal paralysis was given by Duchenne in 1860, and it is known as Duchenne's disease. As physicians, it is our duty to treat those diseases for which there is no treatment; as neurologists, we must grow accustomed to these sights; but as human beings, we must admit there is something wrong in our protoplasm.

One of the major diseases of the world is locomotor ataxia—the aftermath of syphilis, ambushed for years in the neurones, until the posterior columns of the spinal cord collapse. Thus another of the endless victims of the spirocheta pallida joins the army of incoördination, complaining he cannot button his collar or walk in the dark; the physician notes Romberg's sign and the Argyll-Robertson pupil; then drugs and massage and electricity occupy practitioner and patient; advice about avoidance of excitement, and injections of morphine for the tabetic crises; attempting to relieve the symptoms as they occur, and the curtain falls on an unbrained, blinded, bed-ridden paralytic, lower than any beast.

Many have described various aspects of this disease, among the chief contributions of the mid-nineteenth century being those of Martin Steinthal, Moritz Heinrich Romberg, Ludwig Türck, John Russell Reynolds, William Withey Gull—and let us ever remember Edward Stanley and Robert Bentley Todd. They advanced our knowledge of tabes dorsalis, and passed away in full medical harness: the genial Stanley while watching an operation at St. Bartholomew's was attacked by cerebral hemorrhage, within an hour succumbing in the hospital of which he was a part; and Todd saw his last patient and died in his consulting-room—it is a death that will not be forgotten, for the pen of Thackeray has etched it in his *Round-*

about Papers. Gowers, who did much to systematize the accumulating facts of neurology, contends that if the name of any man is attached to locomotor ataxia, it should be the name of Todd. But though we speak of Todd's cirrhosis, tabes dorsalis is always Duchenne's Disease. His monograph (1858) surpassed all others in clinical understanding and completeness, he differentiated it from the paralyses, he caused it to be accepted as a definite disease, he described its syphilitic parentage, and he named it locomotor ataxia after its most impressive symptom. Much work has been done in locomotor ataxia since Duchenne's time, yet immortality in this field is awaiting some physician yet unborn. Metchnikoff's simple discovery, so easily applied, would prevent this living museum of horrors, and let us hope that Wagner-Jauregg's therapeutic application of malaria to the parasyphilitic diseases will prove a new chapter in psychiatry. If Nature had only made more diseases incompatible with each other, what hopeless misery she would have saved her children!

Many who have occupied the fauteuils of the Forty Immortals are nameless dust to-day, and Duchenne, who received no official honors, lives in his works—the historical student will never be able to see a spinal cord without thinking of Duchenne. We wish we could relate that the monument erected to him in the hospital of the Salpétrière, had been unveiled during his lifetime instead of twenty-two years later, but such is the way of the world. Duchenne was ill the last few years of his life, and when he died from cerebral hemorrhage, he received a beggar's funeral. Over fifty years have gone since his body was laid at rest in the cemetery of Boulogne, and no biography has been written of this pioneer neuropathologist and founder of electrotherapy. The brief sketches that have appeared in French and English are altogether inadequate.

Is there no pen to tell the story of the sea-captain's son who sailed deeper waters than mariner ever knew; who touched harborless shores where lay strewn the wreckage of humanity;

who penetrated unknown lands to raise a lighthouse for the tempest-tossed sailors of life? The history of medicine is replete with great names, but we cannot afford to forget the genius and the devotion of Duchenne of Boulogne.

(1813–1878)

CLAUDE BERNARD

To be sure, the world has long been acquainted with fragments of a science of general biology, for Aristotle was a general biologist. His powers of abstraction and his only less marvelous powers of collection, observation, and classification gave rise to a treatise on biology which, with all its faults, is general, and which held the field for many centuries. The intrinsic activities of living matter were, however, completely unknown to him, and so remained until the times of Mayow and of Lavoisier and Laplace. Hence, general physiology, which, when broadly defined, makes up a great part of general biology and affords almost the only opportunity for the biological use of many of the most powerful scientific methods, is a modern science. It was first clearly conceived by Claude Bernard who, when he died fifty years ago, left behind a program for the new science that he himself had gone far to carry out. Claude Bernard held and clearly explained that it is the task of general physiology to study the phenomena of life which are common to animals and plants. These phenomena are physical and chemical phenomena; they are to be investigated by physical and chemical methods; they are conditioned by the same physical and chemical forces that may be discovered among inorganic phenomena. But in the living being they are also always harmoniously organized and integrated, and this is their most striking characteristic. It gives rise to the central problem of general physiology. Especially with the help of his theory of the milieu interieur, Claude Bernard was able to treat many facts, including his own discoveries, from this point of view and thus to embody in durable form ideas which were in advance both of the spirit of his contemporaries and of his own physico-chemical knowledge.

LAWRENCE J. HENDERSON: *Blood,* 1928.

XXIII

CLAUDE BERNARD

I

January 1925! It seems only yesterday that we were living in the nineteenth century and felt very modern, but the first quarter of a new era is already completing its cycle. We are no longer contemporaries of the nineteenth century, we are its posterity. We are so far removed from its presence, that we can view it only in historical perspective, and we now see that some of its dominating scientists, like Cuvier and Broussais, really belonged to the pre-Renaissance, while others, like Claude Bernard, stood at the threshold of the future.

It is remarkable how many paths in modern physiology and medicine start from the laboratory door of Claude Bernard. The secrets hidden in the internal secretions of the ductless glands are writing a new story of science, and Claude Bernard is the author of such chapters as Understanding the Pancreas, the Romance of the Liver, the Conversion of Glycogen, and the Puncture that Produces Diabetes. The very term, internal secretion, (*sécrétion interne*), is of Claude Bernard's coinage.

One would like to believe that this master of experimental medicine passed the winter of his life in happy comfort amidst his devoted family. But if you had knocked at No. 40 Rue des Écoles, you would have found that Claude Bernard lived alone with an old housekeeper who never let her duties to God interfere with her services to the physiologist. Claude Bernard sacrificed his home on the altar of his laboratory. Early in his career, this investigator made a bitter discovery—his wife was not interested in the experimental method. Hearing from his companions that he was clever, she demanded that he employ his talents to build up a large practice. That he should lock himself up in his laboratory, and after a long period of hard work emerge with nothing but the discovery of the vasomotor system, filled her with undisguised indignation. Claude Bernard knitted his ample brow, and realized he must choose between his spouse and science. But the rough call of Magendie, "I say, you there, I take you as my *préparateur* at the Collége de France," rang in his ears as a sacred passport to the temple of the experimental method, and Claude Bernard remained forever within its portals. The outraged Madame gathered together her belongings, took her daughters with her, and left the scientist homeless. A highly incensed police commissioner, who found in the belly of his missing dog, "the accusing cannula of a physiologist," later became the friend and protector of Claude Bernard, but his family remained unforgiving. His daughters grew up to hate their father, and one of them, who regarded him as a sinful vivisector, devoted her spare money to founding hospitals for cats and dogs.

Claude Bernard never had a son, but he had a spiritual heir who succeeded him as Professor of Experimental Medicine at the College of France, and wore his mantle, if not with all the master's greatness, at least with a never-failing piquancy. We refer of course, to that enthusiastic, impulsive, roving, restless physiologist, Charles Édouard Brown-Séquard. Everything connected with this name is interesting. Brown-Séquard's nationality is a problem in ethics, ethnopsychology and anthropology, for he was born on the Island of Mauritius, the posthumous son of a Philadelphia-Irish sea-captain and a French girl, and yet regarded himself as a British subject, although he preferred to live in Paris. The mariner evidently found no fortune upon the waters, for after his death his widow found it necessary to support herself and child with the needle. Her family name was Séquard, and her son added this to his father's more prosaic patronymic of Brown.

Brown-Séquard's first passion was literature, and as his early efforts met with success, when he and his mother sailed for France, during his twenty-first year, he carried with him the manuscript of a novel and a letter of introduction to one of the most romantic figures in French literature—Charles Nodier. Politician and entomologist, wanderer and booklover, newspaper editor and lexicographer, exile and Academician, prisoner and member of the legion of honor, bohemian and librarian, likewise historian, philologist, dramatist, poet, biographer, and patron of Victor Hugo, Alfred de Musset, Sainte-Beuve, and a host of lesser authors, Nodier drank deeply from the cup of life. The career of Nodier, without any embellishments, would make a drama of intense and ever-shifting scenes. Nodier, who had written dissertations on themes ranging from the antennæ of insects to a diary of emotions of a love-sick heart, knew the uncertainty of literary rewards, and advised Brown-Séquard to become a doctor.

It is curious to recall that Claude Bernard, also at the age of twenty-one, had come down to Paris from his vine-covered cottage on the hill-slopes of Beaujolais, bringing the manuscript of a dramatic tragedy in five acts and a letter of introduction to the famous critic, Saint-Marc Girardin, professor at the Sorbonne. Claude Bernard's vaudeville sketch, La Rose du Rhône—composed during drug-store days—had already been produced with success, and Girardin acknowledged that his ambitious drama possessed considerable merit, but he put his hand on the young provincial's shoulder, and said kindly, "You already know something about pharmacy; now study medicine, and you will be more sure of making a living." Thus, to the advice of two eminent literary critics, endocrinology owes its chief founders, Claude Bernard and Brown-Séquard.

Brown-Séquard plunged into medicine with his usual ardor, but many years were to elapse before he obtained his M.D., for a dissection-wound interrupted his studies for a time, and then the death of his mother darkened the world for him. Stunned with pain and incapable of work, he began a career of restless wandering that was Paracelsian.

Finally graduating at Paris with a thesis on "Researches and Experiments on the Physiology of the Spinal Cord," he entered a military hospital, and in due time fought a cholera epidemic; opposing the imperialism of Louis Napoleon, he fled to America when the usurper was successful; upon returning to France, he decided to practice in Mauritius, and landed among the coral-reefs of the Indian ocean in the midst of another cholera outbreak; soon he was in America again, teaching medical jurisprudence at the Virginia Medical College; but Paris called, and here he made his mark by his lectures on the nervous system; when the National Hospital for the Paralyzed and Epileptic was opened in London, the physician-in-chief was no other than Brown-Séquard, and later he taught and practiced in various cities of Scotland and Ireland; the news spread throughout the medical circles of the United States that Boston had a brilliant professor of neurology—it was Brown-Séquard; Harvard could not hold him, and he returned to Paris to teach comparative and experimental physiology, and to edit a medical journal; few men can leave the allurements of a combined professorial and editorial chair, but we next find Brown-Séquard an active practitioner in New York; our metropolis lost him, and London and Paris again knew his bronzed face and those long locks; in Geneva he became professor in physiology, and just as Switzerland was about to congratulate herself that she had acquired the international scientist, he stepped over the Alps into Claude Bernard's place at the College of France.

One would be justified in surmising that a physician who from youth to age had been driven across continents by travel fever, would be incapable of completing much scientific work, but this amazing individual, eternally traveling, lecturing, practicing, experimenting, produced a bibliography so copious that it has never been compiled. The fame of Brown-Séquard is popularly associated with one spectacular experiment, but as a matter of fact he produced solid work of an enduring character, such as his pioneer investigations on the physiology of the spinal cord, his numerous researches in the nervous system, and his artificial production of epilepsy and its inheritance. After confirming by original experimentation, Claude Bernard's discovery of vasoconstrictor nerves, which has become "one of the keystones of modern physiology," Brown-Séquard followed the master into the realms of endocrinology, clearing new paths by his production of Addison's disease by excision of the suprarenal capsules, by his advocacy of spermato- and organo-therapy, by his treatment of acromegaly by animal extracts, by his contention that the ovaries and kidneys possess an internal secretion, and by his pronouncement, "The internal secretions whether by direct favorable influence, or whether through the hindrances of deleterious processes, seem to be of great utility in maintaining the organism in its normal state."

The years passed, and Brown-Séquard grew old. Honors came to him, and in his sixty-third year he received the LL.D., from Cambridge. At that session, the highest honorary degree of the University was likewise bestowed upon the American surgeon, Samuel David Gross, then seventy-five years of age, and the elder man wrote in his Autobiography, "Dr. Brown-Séquard I had seen many years before, but I had not met him for a long time, and was sorry to find that he looked much older than is usual with one of his age."

Nine years later, Brown-Séquard, at seventy-two, was aged indeed. Beneath the dying flames of his ardor for science, only a few embers now flickered. The fire of Brown-Séquard had burnt out amidst the ashes of the years. He was irritable, impotent, suffered from gastrointestinal troubles and was plagued by urinary disturbances, and no longer cared to be surrounded by eager students in a laboratory. His career appeared over, and it seemed as if no new laurels would weigh down that wrinkled brow.

But Brown-Séquard's greatest day was yet to come: on June 1, 1889, he stood before the Société de Biologie and added a new thrill to science. The Brown-Séquard who addressed his colleagues on that historic day, looked twenty years younger than the Brown-Séquard they had known, and he reported that by testicular injections he had rejuvenated himself: his irritability, impotence, gastric and vesical infirmities had disappeared, and by means of the dynamometer and the ergograph he demonstrated his increased strength and energy. He rolled the clock of time backward for two decades, and mentally, physically, sexually, Brown-Séquard at seventy-two resembled the Brown-Séquard of fifty-two.

When his reports appeared in the Archives of Physiology, which Brown-Séquard edited in collaboration with Vulpian and Charcot, there arose an uproar of incredulity and wrath which has not yet entirely subsided. His alleged results were ascribed to his "senile-erotic imagination," and many physicians were either incensed or amused at what they considered the obscene folly of a scientist in his dotage. Brown-Séquard insisted that not chemical substances of the gland, but emulsions of the testicle were essential for success, yet he was discredited by men who did not even attempt to follow his technique. However, in the wilderness of ignorance, Brown-Séquard had opened a path which has since grown into one of the main-traveled roads of modern science. Even so conservative an endocrinologist as R. G. Hoskins, regards June 1, 1889, as the "definite birthday" of the science of the internal secretions, and Arthur Weil states that on that day Brown-Séquard laid the corner-stone of endocrinology.

The literature of endocrinology is now so voluminous that its mere bibliography occupies several hundred closely printed pages, and this gigantic tree of knowledge, putting forth new branches every day, sprang from the seed planted by Brown-Séquard. Five years later, in the spring of 1894, when Brown-Séquard passed away at the age of seventy-seven, the mantle which he had inherited from Claude Bernard fell upon the shoulders of an investigator who was able to build a complete system of medicine upon the internal secretions.

Toward the end of 1852—the very year in which Brown-Séquard fled from France to America to escape the tyranny of the little Napoleon—there was born at sea, on a ship returning from America to France, a child named Charles Eucharist de' Medici Sajous. Thus the man Brown-Séquard and the babe Sajous passed each other at sea, but the day came when their ships arrived in the same port.

The young Sajous was educated in France, mainly in private schools and by tutors; later he was a student at the University of California, and at twenty-five was graduated from the Jefferson Medical College of Philadelphia. He entered practice, devoting special attention to diseases of the nose and throat. He was appointed lecturer on laryngology at his alma mater, and afterwards became dean and professor of laryngology at the Medico-Chirurgical College. His first articles, all confined to his specialty, were Glacial acetic acid in nasal hypertrophy; A case of abductor paralysis due to lead poisoning; Two cases of fracture of the thyroid cartilage; Inhalations in laryngeal and pulmonary affections; A new wire snare écraseur; Notes on hay fever; Hydrochlorate of cocaine in the treatment of nasal affections; Modification of Cohen's laryngeal forceps, making them adaptable for post-nasal, pharyngeal, and laryngeal applications. These fugitive pieces were followed by two meritorious manuals, The Treatment of Hay Fever and Lectures on the Diseases of the Nose and Throat, but it was not in laryngology that Sajous was destined to leave his mark. At the cross-roads, he bade farewell to Manuel Garcia, and turned to the path of Brown-Séquard.

In the latter eighties, the medical literature of the world, while not quite as unencompassable as it has since become, was of sufficient voluminosity to deter most men from attempting a universal survey. At a time when it was bewildering even to contemplate the yearly output of medical periodicals, books, monographs and theses, a daring scholar announced his intention of presenting an annual digest of all current medical and surgical literature, including the fundamental branches and the ever-growing specialties. Sajous proved himself our editorial Hercules by projecting the *Annual of the Universal Medical*

Sciences. Aided by seventy associate editors and by two hundred corresponding editors, the intrepid editor-in-chief ransacked the entire current medical literature of every nation upon the globe, and preserved its essence in the pages of his Annual.

Many of the associates whom Sajous gathered around him in those brave days, have become classic names in American medicine: Joseph Leidy, David Hayes Agnew, William Pepper, Charles K. Mills, Theophilus Parvin, James Tyson, George M. Gould, Hobart A. Hare, and the Solis-Cohens, of Philadelphia; Nathan Smith Davis, Nicholas Senn, Christian Fenger, Emilius C. Dudley, Henry M. Lyman, of Chicago; William H. Howell, of Baltimore; Rudolph Matas, of New Orleans; E. C. Sequin, E. C. Spitzka, Francis Delafield, Bryson Delavan, E. L. Keyes, J. Lewis Smith, Lewis A. Stimson, Joseph O'Dwyer, and the Sayres, of New York. The foreign correspondents hailed not only from the cultural centers of Europe and America, but from Osaka, Japan; Foo-Chow, China; Petchaburee, Siam; Ooromiah, Persia; Seoul, Korea; Adana, Asia Minor; Umsiga, Natal; Beirut, Syria; Madura, South India; Dera Ishmael Khan, Beloochistan; Jerusalem, Palestine; and from Egypt to Teneriffe, and from Melbourne to Trinidad.

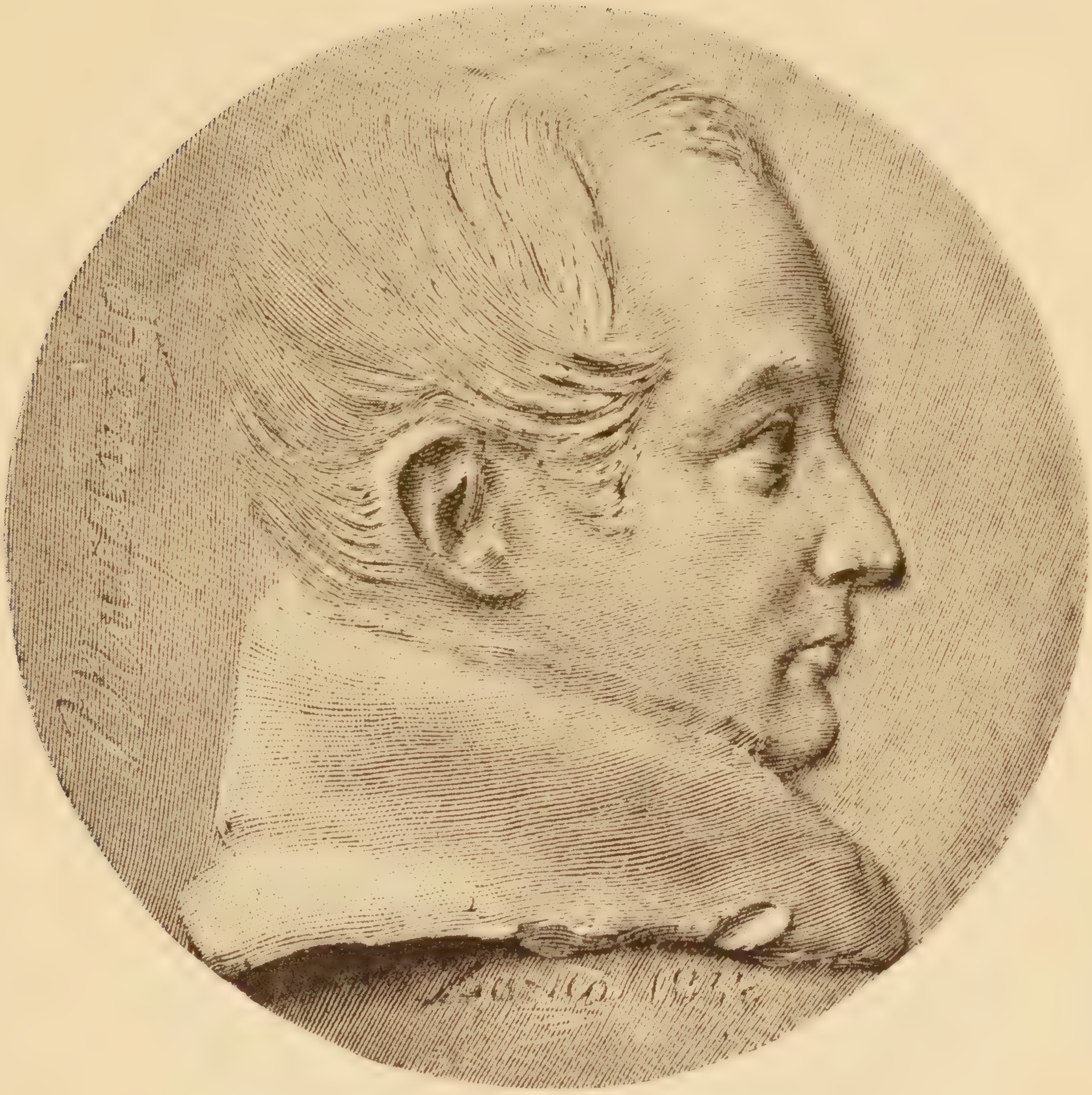
The success of the forty-five volumes of the Annual, in five yearly volumes, was so considerable in all English-speaking countries including the British colonies, that over five hundred thousand volumes were sold during the nine years that it appeared. The panic that began in 1896, however, reduced the financial status of the medical profession, and the first thing a doctor does when he finds himself pressed for funds is to cancel his subscriptions to medical publications. As a result, the subscription-list of the Annual became inadequate to meet the cost of production of a work of such magnitude, and it was discontinued. But a panic was insufficient to dismay Sajous, and he replaced the Annual by the *Analytic Cyclopedia of Practical Medicine,* which was designed especially for the general practitioner, and although published in an era of pharmacologic unbelief, is so rich in therapeutic hints that their enumeration alone occupies a separate index volume. The Cyclopedia is still being published, and over seventy thousand sets, aggregating over six hundred thousand volumes with supplements, have been sold. Medical editors receive few rewards, and it is therefore a pleasure to record that France showed her appreciation of the Annual by making the editor-in-chief an Officer of the Academy and bestowing upon him the Legion of Honor.

Much as the general reader appreciated the Annual, its real value could perhaps be appraised best by men who had themselves undertaken titanic editorial labors, such as Sir Jonathan Hutchinson who edited the Archives of Surgery in ten volumes and wrote the entire contents himself, or Sir Benjamin Ward Richardson who was the sole contributor to the eleven volumes of his Asclepiad. As a matter of fact, Richardson sang pæans to the Annual. We have yet to relate that the chief importance of the Annual was its effect upon Sajous himself: the wide survey thus secured, enabled him to realize that a multitude of gaps existed in all fields of medicine, which his extensive experience as a clinician served to confirm. Therapeutics now seemed to him empirical, instead of rational and scientific. The relationship between cause and effect failed to appear, and if an effort were made to establish it, links were missing on all sides.

A flash of insight came to Sajous, and arranging to edit the Annual abroad, he dropped his practice, hospital and teaching positions in 1892, and repaired to the fountain-head of endocrinology, the land of Claude Bernard and Brown-Séquard, where for several years he literally drank the internal secretions. The date 1892 is of significance in American medicine, for then appeared the first edition of William Osler's *The Principles and Practice of Medicine*—a glorious textbook, but the organon of therapeutic despair. Osler, the adored physician-in-chief of Our Times, preached a keen eulogy over superannuated Therapeutics, while Sajous sought to revive her with injections of the internal secretions. Claude Bernard had passed away in the year that Sajous took the Hippocratic Oath, but Brown-Séquard remained in the flesh to inspire the eager truth-seeker.

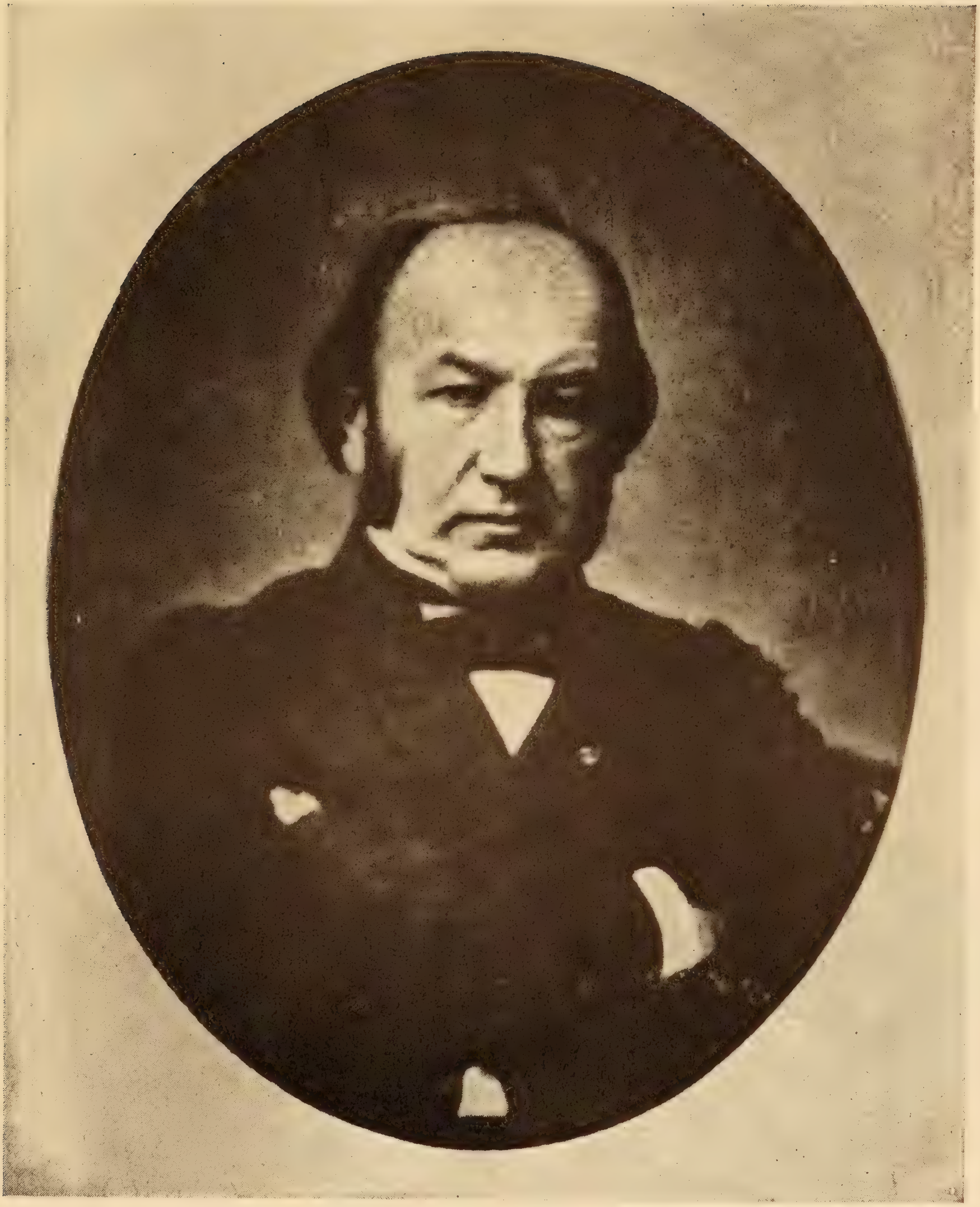
For ten years Sajous wrestled with the mysteries of endocrinology, and in 1903 a volume came from the press bearing the title, *The Internal Secretions and the Principles of Medicine.* Brown-Séquard was no longer here to welcome it, and the book was dedicated to his memory. This was the first treatise ever published on the internal secretions, and while all subsequent works stress the functions and diseases of the endocrines *per se,* Sajous' book introduced a new conception of medicine as a whole. Sajous maintained, that to the standard organs, such as the liver, lungs, heart, kidneys, we must add various others of major importance, such as the adrenals, thyroid, and pituitary, in the study of the pathology, diagnosis and treatment of all diseases. Time has sustained the endocrinologist, for who to-day would consider an examination or an autopsy complete without a study of the ductless glands? Who to-day would approach any phase of practical medicine without due recognition of the internal secretions? Sajous' book was entirely ignored by medical officialdom, for in 1903—and even in 1907, when the second volume appeared—endocrinology played a lesser rôle in medicine than did thalassotherapy.

The author's literary industry was what might be expected from the editor of the Annual and the Cyclopedia, but these volumes on the internal secretions do not only abound with references and footnotes, but teem with original conclusions and clinical observations, while facts and hypotheses crowd each other on every page, yet all correlated and forming the Sajous System of Medicine. To wander through these massive volumes is equally stimulating and disconcerting, for while endless vistas and panoramas are unrolled before the delighted traveler, he may be hopelessly lost when he attempts to follow Sajous into such labyrinths as: Subsidiary adrenal and interrenal tis-

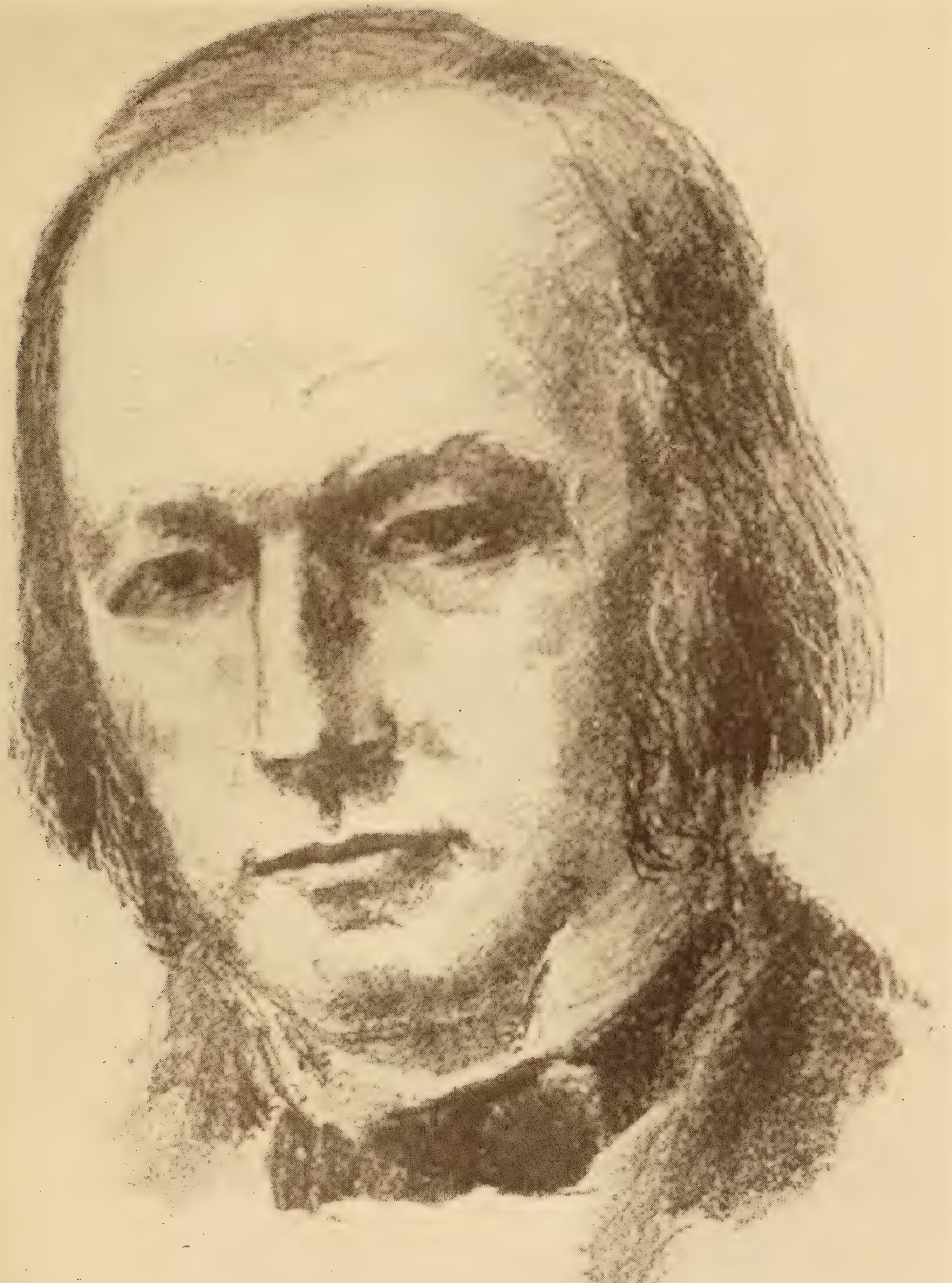


FRANÇOIS MAGENDIE

The David d'Angers Medallion engraved by E. Schladitz.



CLAUDE BERNARD



CLAUDE BERNARD
Drawing by Berthold Mahn.

ERNEST RENAN
From a bronze plaque in the author's library.

sues; terminal hypoadrenia; the pituitary body as the seat of the thyroparathyroid center; dementia præcox and dysfunction of the internal secretions; the adrenal secretion as the source of the functional activity of the right heart; the posterior pituitary body as the somatic center of the nervous system; the adrenal system as the foundation of immunity; oxidase as a respiratory constituent of all organisms, and as the albuminous constituent of hemoglobin; adrenoxidase as secretin; the active principle of adrenoxidase as the dynamic element of life; the pituitary body as the governing center of the adrenals, and as the thermogenic and respiratory center, and its neural lobe as the seat of common sensibility and as the general motor center; the internal secretions in their relation to pathogenesis and pharmacodynamics; the internal secretions as the body's auto-protective substances and as the foundation of rational therapeutics. After coming upon unnumbered conclusions opposed to the standard textbooks, the bewildered inquirer exclaims: Is it possible, that in spite of the vaunted progress of science, we really know so little? And Echo answers, from the thymus to the spleen: So little.

Sajous' broad conception of the adrenal system; his claim that the adrenals must be accepted as the essential source of the agents through which both pulmonary respiration and tissue oxidation are maintained; his thesis that the suprarenal, pituitary and thyroid glands, including the tryptic enzyme, constitute the immunizing mechanism of the body; his warning against the dangers of the iodine treatment in exophthalmic goiter; his views on the nervo-vascular mechanism of the lungs; his explanation of the thyroparathyroid secretion as an oxidation activator through its action on cellular phosphorus; and his interpretation of the family relationship of the ductless glands, are of sufficient ingenuity to put an army of investigators to work.

"Since the development of the bacterial theory of infection," writes the distinguished historian, Fielding H. Garrison, "there is probably no pathological concept that has latterly so dominated modern medicine as the doctrine of the internal secretions of the ductless glands. In virtue of this theory—which, like that of the specific infectious diseases, is founded upon rigid laboratory experimentation—we are what we are, bodily, mentally, sexually, emotionally, facially, largely through the balance or imbalance of certain secretions, discharged in minute quantities into the blood by a set of glands which have no excretory ducts communicating with the external world, and upon disturbance of function of one or more of these glands depends a large group of unusual and hitherto unclassified diseases."

We must admit, however, that endocrinology has not duplicated the almost uninterrupted triumphs of bacteriology. Bacteriology is a full-grown science steadily marching forward on its well-defined technique, but endocrinology, after striding ahead like an invincible giant, suddenly totters and falls prostrate. For example, a series of articles on endocrinology, published by the Journal of the American Medical Association, has just reached its finis, and is to appear in pamphlet form. All through this series of articles prepared by our leading scientists, there runs a dirge with this accompanying refrain: obscure, unknown, mystifying, no precise knowledge, not yet isolated.

Sajous lays the blame for this deficiency squarely upon the shoulders of the physiologists. Sajous openly declares that between the physiological method of endocrinological research and his own method there is not a bridge, but a chasm. He regards physiology as but one subdivision of the medical sciences, and claims that the domination of animal experimentation over all other lines of medical thought is responsible for therapeutic impotence. Sajous feels that from the date of publication of his work on the internal secretions, if he had been followed instead of the physiologists, five million human beings who are now in their graves, would be alive—and it is perhaps fortunate that there is no justification for this claim. He insists that the physiologists have not to this day discovered the functions of a single ductless gland, and that the knowledge gained by manipulating a normal guinea-pig cannot be transferred to a sick human biped. In connection with endocrinology, perhaps some future Allbutt will write on the Historical Relations Between Physiology and Therapeutics. Sajous has been editor, author, teacher, but essentially he has remained the bedside practitioner. Most of us now believe that along the bio-chemical road lie the solutions of our problems, but Sajous preaches that here are spread the pitfalls that lead to error, and that endocrinological truth will be found upon the deserted clinical road.

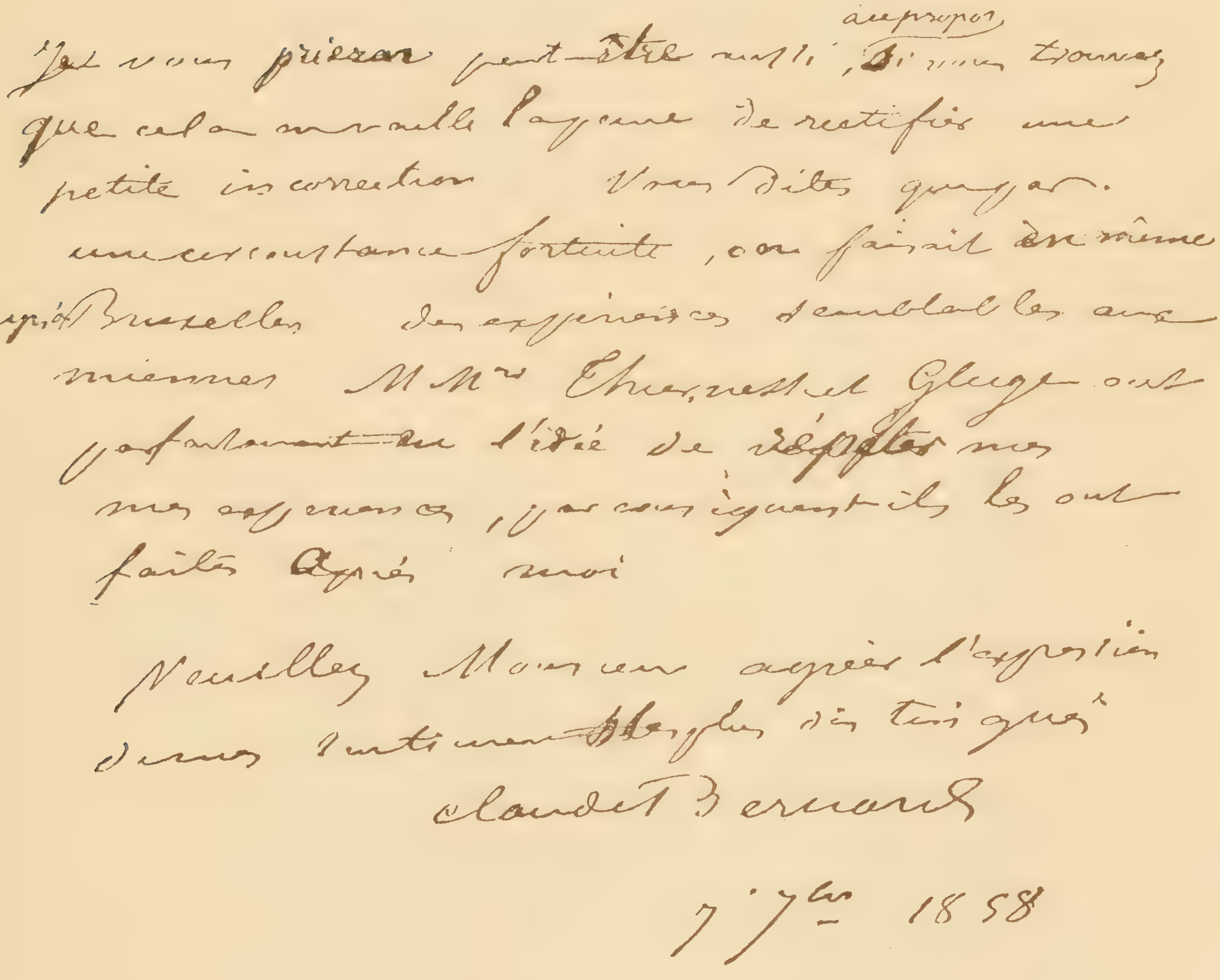
Under these circumstances, it is piquant to recall that in his latter twenties, Sajous was professor of physiology at the Wagner Institute of Science, and that he is a direct descendant of those arch-physiologists, Claude Bernard and Brown-Séquard. In view of the ceaseless bibliography of the internal secretions, the majority of us may have gained the impression that we are witnessing the Renaissance of Endocrinology, but in various communications which the present writer has received from Professor Sajous, he informs us that we are living in the dark days of endocrinology.

If we do not follow Sajous in his physiological onslaught, it is because from the historical viewpoint endocrinology has not encountered undue obstacles in its progressive development. In spite of the droughts of ignorance and the frosts of misunderstanding, the fields tilled by such pioneers as Théophile de Bordeu, Caleb Hillier Parry, Carl Adolph Basedow, Robert Graves, Thomas Addison, Theodor Kocher, J. L. Reverdin, Moritz Schiff, Alfred Fröhlich, Joseph von Mering, Oscar Minkowski, Giulio Vassale, Francesco Generali, Eugene Gley, Victor Horsley, G. R. Murray, and numerous others, have borne such glorious fruit that to-day we can say with Roy Graham Hoskins: "When we see misshapen, stunted imbeciles transformed to normal, happy children, diabetics starving in the midst of plenty restored to health and strength, giants and dwarfs produced at will, sex manifestations engendered or reversed before our eyes by control of endocrine factors, who can regard endocrinology as other than a most significant phase of modern biology?"

It is eminently fitting that Sajous, who wrote the first book on endocrinology, and was unanimously elected first president of the Association for the Study of the Internal Secretions, and opened the first scientific session of the Endocrinological Society of New York, should likewise be the first professor of endocrinology. As the veteran fighter approached his seventieth year, the oldest medical school in America created for him the first chair of endocrinology in the history of medicine, and thus Sajous, who was once regarded as a heretic, is now the anointed Professor of Applied Endocrinology in the University of Pennsylvania Graduate School of Medicine. His son, Louis Theo de' Medici Sajous, is instructor in endocrinology in the same school.

Sajous has been termed "the most robbed man in America," and it is no exaggeration to say that many writers, unwittingly or otherwise, claim endocrinological offspring whose real parentage will be found in the first edition of *The Internal Secretions and the Principles of Medicine.* If Sajous ever secures the leisure, perhaps he will write a book on Priority. Should he ever be tempted to do so, he could easily afford to be magnanimous, for although he has stood apart from the main trend of American medicine, he is one of our few physicians with a therapeutic message: and in his own lifetime he has seen himself become an historic figure, and he must realize that the influence of Sajous will be felt by coming generations of medical men.

The Koch or Pasteur of the internal secretions has not yet arisen. We stand to-day at the gates of endocrinology, but cannot pass beyond. Another generation shall enter, and much that is closed to our eyes, shall be open to those who succeed us. Where we stumble in darkness, they shall advance by the light of the new knowledge. Where we attempt to halt the



Je vous prierai peut-être aussi, à propos, si vous trouvez que cela en vaille la peine de rectifier une petite incorrection. Vous dites que par une circonstance fortuite, on faisait en même temps à Bruxelles des expériences semblables aux miennes. MM. Thiernesse et Gluge ont parfaitement eu l'idée de répéter mes mes expériences, par conséquent ils les ont faites après moi.

Veuillez Monsieur agréer l'expression de mes sentiments les plus distingués

Claude Bernard

7 7^{bre} 1858

MEDAL AND HANDWRITING OF CLAUDE BERNARD

monsters of disease with imperfect weapons, they shall conquer with swords dipped in a hundred discoveries. When plaudits ring for some young endocrinologist who has overthrown an ancient enemy of the human race, few may be filial enough to remember in whose footsteps they follow, and thus we give to posterity this eponym: Charles Eucharist de' Medici Sajous, the Father of Endocrinology in America.

Several years ago we uttered a Physician's Prayer, and on the coming of the present new year we sent some copies to the profession. Professor Sajous received it with such gracious comment, that we reprint it here as a credo for all those who enlist under the Hippocratic banner: Without hauteur or the braggart's tongue, not with an assumption of superiority over others, but as students seeking the truth, and as men sobered by the part we play in the drama of life-and-death, conscious of our limitations, rejoicing in what we have achieved throughout the ages, grateful for the many discoveries of modern times, with a vision of what is yet to be, let us press forward to the work that lies before us in the long road to our dream of the diseaseless future!

II

Claude Bernard, born July 12, 1813, in the village of Saint-Julien, not far from Villefranche, grew up among his father's vineyards—several scientists were the sons of brewers and wine-growers—and in the years of his renown, Bernard had for this vineyard the same affection that Pasteur felt for his father's tannery. "My dwelling," wrote Bernard, "is on the hill-slopes of Beaujolais which look towards the Dombe. The Alps give me my horizon and when the air is clear I can catch sight of their white summits. At the same time I see spread out before me for two leagues the prairies of the Saône. The slope on which I dwell is surrounded on all sides by vineyards stretching away apparently without limit; these would give the country a monotonous appearance were not this broken by wooden valleys and brooks running down from the mountains to the river. My cottage, situated though it is on a rise, is a very nest of verdure, thanks to a little wood which shades it on the right and to an orchard which flanks it on the left; a great rarity in a land in which they stub up even the coppices in order to plant vines."

Bernard was considered promising enough to be sent to school at Lyons, but financial reasons made him exchange an academic education for the practical experience of an apothecary shop. Bernard as a pharmacist's assistant, compounding drugs, carrying medicines to the Veterinary School, being instructed to throw all spoilt drugs into a popular syrup, reminds us of Ibsen serving as a drug-clerk for seven years; but fate decreed that the grim Norwegian should fail to pass his entrance examinations at medical college, thus permitting him to become the master pathologist of society, while Claude Bernard after writing two plays, enrolled as a student of the healing art. At Lyons, Bernard had two friends, poor and ambitious as himself, also bound for the capital where they promised to meet each other. Naturally they forgot this promise as soon as they reached Paris, and it was not until several years later that accident brought them together in front of the Pantheon. It was then found that one had become a Bishop, the other was a Director of Railways, while Claude Bernard was the least lucky in worldly goods.

Claude Bernard's career as a medical student was not successful; the successful medical student honors his teachers and has no gods but the curriculum. The more Claude Bernard listened to the theories of his teachers, the more familiar he became with their methods and notions, the more he realized that a strong conviction is not equivalent to a fact, and that an eloquent disputation is not the proper foundation for scientific medicine.

SECOND SCHOLAR.
And what are the studies you pursue?
What is the course you here go through?
FIRST SCHOLAR.
The first three years of the college course
Are given to Logic alone, as the source
Of all that is noble, and wise, and true.
SECOND SCHOLAR.
That seems rather strange, I must confess,
In a Medical School; yet, nevertheless,
You doubtless have reasons for that.
FIRST SCHOLAR.
O, yes!
For none but a clever dialectician
Can hope to become a great physician;
That has been settled long ago.

In doubt, and often in darkness, Claude Bernard kept on with his studies, and in his fifth year came in contact with the scalpel of Magendie. This scalpel was often aimless and cruel, but by cutting through endless word-spinning and unravelling well-knotted subtleties, it did its share in adding the experimental method to pharmacology and physiology. Magendie was the stepping-stone by which Claude Bernard crossed from the mists of speculation to the clear air of modern science.

Magendie's position in medicine is analogous to Zola's in letters, and it is interesting to compare their statements. "I am," said Emile Zola, "a positivist, an evolutionist, a materialist; my system is heredity. I have found the instrument of my epoch. I wish to be a painter of life. I must therefore ask of science to explain life to me. . . . I make it my business neither to approve nor to blame. I am simply a merciless investigator, eager to take apart the human machine, wheel by wheel, train by train, in order to see a little how the mechanism works and comes to effect such curious results." François Magendie declared: "Every one is fond of comparing himself to something great and grandiose, as Louis XIV likened himself to the sun, and others have had like similes. I am more humble. I am a mere street scavenger of science. With my hook in my hand and my basket on my back, I go about the streets of science collecting what I find."

Claude Bernard's researches were not only significant in themselves, but the methods by which he reached his results stand as guide-posts for future workers. Important as were his discoveries of the glycogenic function of the liver, of the vasomotor system, and of the threefold action of pancreatic juice, momentous as was his insight into the regulation of the blood-supply of the body, his production of disease by artificial means, and his conception that the body not only breaks down chemicals but by building up complex substances performs a physiological synthesis, the name of Claude Bernard is on the lips of present-day investigators, not so much because of these finished achievements, as because the unsolved problems of life and disease and death are approached by the methods he introduced.

The methods of medical research must be learned by all who investigate problems, and yet in the last analysis the method itself is unimportant. No one has stated this better than Claude Bernard, the master of method: "The experimental method cannot give new and fruitful ideas to men who have none; it can only serve to guide the ideas of men who have them, to direct their ideas and to develop them so as to get the best possible results. As only what has been sown in the ground will ever grow in it, so nothing will be developed by the experimental method except the ideas submitted to it. The method itself gives birth to nothing. Certain philosophers have made the mistake of according too much power to method along these lines." Just as one who has learned the technique of prosody and is familiar with the rules of versification may be unable to produce a lyric, so a man may be trained a lifetime in the best methods and principles of research, and at the crucial moment may fail to recognize a discovery bubbling before him in a test-tube.

Claude Bernard undertook his investigations of South American curare, and found why carbon monoxide is a prompt poison, not because he was working out a method, but because it was the natural, intuitive and inevitable thing for him to do;

he followed the chorda tympani and the spinal accessory nerve, he grappled with recurrent sensibility, for the same reason that Schumann in 1840 overflowed with more than a hundred songs. As Paul Bert said of Claude Bernard, "He discovered as others breathed."

Perhaps Claude Bernard followed Girardin's advice too faithfully, for aside from *Leçons* he wrote little, though it should be remembered that these *Leçons* occupy seventeen octavo volumes. His aphorisms are Hippocratean in conception, and his method of expression—graphic, dramatic, yet eminently simple—is unsurpassed in medical literature. He is as quotable as Huxley, as the following extracts will reveal:

Scientific medicine, gentlemen, which it ought to be my duty to teach here, does not exist. (1847.)

Put off your imagination as you take off your overcoat, when you enter the laboratory; but put it on again, as you put on your overcoat, when you leave the laboratory. (Popularized by Michael Foster.)

If I wished to express my feeling of the science of life, I should say it is a noble salon, glowing with light, to which one can go only by passing through a great and disgusting kitchen. (Baas, in one of his characteristic footnotes, claims that the nudities and brutalities of Zola were palliated and ostensibly necessitated by this remark of Claude Bernard.)

Our ideas are only intellectual instruments which help us to penetrate phenomena. We should drop them when they have served their turn, even as one scraps a bistoury grown rusty from long usage. (In Garrison's Medical Proverbs, Aphorisms and Epigrams.)

Those who have made the most discoveries in science are those who have never known Bacon; and those who have read him and meditated upon him have, like Bacon himself, had but little success as inquirers. (In Foster's chapter, Later Writings of Claude Bernard.)

To sum up, even mistaken hypotheses and theories are of use in leading to discoveries. This remark is true of all the sciences. The alchemists founded chemistry by pursuing chimerical problems and theories which are false. In physical science, which is more advanced than biology, we might still cite men of science who make great discoveries by relying on false theories. It seems, indeed, a necessary weakness of our mind to be able to reach truth only across a multitude of errors and obstacles, (This, and the following quotations, are from Henry Copley Greene's 1927 translation of Introduction to the Study of Experimental Medicine.)

> *Experimenters do not grow great by the number and complexity of instruments; it is really the other way. The great experimenters, Berzelius and Spallanzani, made great discoveries by means of simple instruments. In the course of this work, our principle, then, will be to seek, as far as possible, to simplify means of study; for instruments must be allies, not sources of error because of their complications.*
>
> *Men who have excessive faith in their theories or ideas are not only ill-prepared for making discoveries; they also make very poor observations. Of necessity, they observe with a preconceived idea, and when they devise an experiment, they can see, in its results, only a confirmation of their theory. In this way they distort observation and often neglect very important facts because they do not further their aim. This is what made us say elsewhere that we must never make experiments to confirm our ideas, but simply to control them; which means, in other terms, that one must accept the results of experiments as they come, with all their unexpectedness and irregularity.*
>
> *When we meet a fact which contradicts a prevailing theory, we must accept the fact and abandon the theory, even when the theory is supported by great names and generally accepted.*
>
> *Physics and chemistry, as established sciences, offer us the independence and impersonality which the experimental method demands. But medicine is still in the shades of empiricism and suffers the consequences of its backward condition. We see it still more or less mingled with religion and with the supernatural. Superstition and the marvellous play a great part in it. Sorcerers, somnambulists, healers by virtue of some gift from Heaven, are held as the equals of physicians. Medical personality is placed above the science by physicians themselves; they seek their authority in tradition, in doctrines or in medical tact. This state of affairs is the clearest of proofs that the experimental method has by no means come into its own in medicine.*
>
> *Ardent desire for knowledge, in fact, is the one motive attracting and supporting investigators in their efforts; and just this knowledge, really grasped and yet always flying before them, becomes at once their sole torment and their sole happiness. Those who do not know the torment of the unknown cannot have the joy of discovery which is certainly the liveliest that the mind of man can ever feel. But by a whim of our nature, the joy of discovery, so sought and hoped for, vanishes as soon as found. It is but a flash whose gleam discovers for us fresh horizons, toward which our insatiate curiosity repairs with still more ardor. Thus, even in science itself, the known loses its attraction, while the unknown is always full of charm.*

If time these days were not so fleeting, and duties not so clamorous and pressing, it would be delightful to make a leisurely study of Claude Bernard's relationship to two of the most interesting of French philosophers—Auguste Comte and Ernest Renan:

Auguste Comte has been neglected by medical historians, perhaps because he was slaughtered by Huxley, though his relationship to the sciences is more intimate than the much-lauded Francis Bacon—likewise demolished by the same valiant hand. In his youth, Comte petitioned Guizot—of course, in vain—to establish a chair in the history of science. Guizot, a famous leader without vision, countenanced numerous courses in theology, metaphysics and philosophy—dealing largely with ancient errors—but he was too biased to see the value of a general survey of the sciences. At the age of twenty-four, Comte had written a plan of the scientific works necessary to reorganize society, and his positive philosophy is a remarkable commentary on physics and chemistry, physiology and biology. George Henry Lewes who devoted a volume to Comte's Philosophy of the Sciences, maintains that "a Philosophy of Science is nowhere to be found except in the work of Comte, which comes forward with the express purpose of supplying the deficiency." Auguste Comte, founder of the religion of humanity, yet a misfit among his fellow-men; a systematic thinker of the first rank who made philosophy pay tribute to science, yet remained a lonely figure in the realm of thought; exemplar of reason, yet attacked by insanity; champion of the equality of woman, yet unhappily married; preaching the gospel of a new civilization, yet ungrateful and arrogant to a Mill and a Littré; unhonored by the public, in poverty and obscurity, and with increasing egotism, he passed the bitter years until cancer closed the scene. A preposterous man, with the practical judgment of a wilful child, yet the manuscripts he carried to the printer enlarged the horizon of humanity, and among his disciples was Claude Bernard.

A more amiable man was Claude Bernard's friend who succeeded to his arm-chair at the French Academy, and pronounced his *Éloge* in sinuous French. Ernest Renan expected to pass his existence on earth in a Breton cassock; against his own inclinations, his developing intellect drove him to science; despite himself, one by one his books brought consternation to ecclesiasticism. "I wish to have on my tomb," he said, "these words, *Veritatem dilexi.* Yes, I have loved the truth, sought it, followed whither it called me, without regard to the sacrifice entailed. I broke the links that were dearest to me that I might obey it." Renan retained a loyal affection for the priesthood, but no man did more to destroy it. At sundown he bowed in reverence before the chimes of the village Angelus, while subtly dethroning God. How he could handle the French language!—"a sculptor in speech, a colorist in words." Expelled by officialdom from his chair of Hebrew, he relied upon his pen: the pen that beguiled with soft words, and suddenly struck forth like a rapier. Guided by his saintly sister, this pen committed "the boldest act of the nineteenth century." In a former age Ernest Renan would have perished in fire: he lived to become portly, rheumatic, and the idol of France.

That English author who hated Frenchmen so heartily that he insisted the Gallic children, roosters, dogs and frogs were noisier than the corresponding species in the British Isles, likewise held decided views on marriage, as these words will attest: "Death itself to the reflecting mind is less serious than marriage. The elder plant is cut down that the younger may have room to flourish: a few tears drop into the loosened soil, and buds and blossoms spring over it. Death is not even a blow, it is not even a pulsation; it is a pause. But marriage unrolls the awful lot of numberless generations. Health, Genius, Honour, are the words inscribed on some; on others are Disease, Fatuity, and Infamy." These solemn views did not prevent Walter Savage Landor from marrying rashly and disastrously: in the wintry years of his life he received the homage of a Browning and a Swinburne, but he could not warm himself at his own fireside. As already indicated, Claude Bernard was in a similar plight, and one who worshipped him, wrote: "Claude Bernard had a scientific family and all his disciples loved him tenderly. It is to their eternal honor that they did not neglect the master or allow him one sad day after his wife and daughters cruelly abandoned him. So, at night, when they came to-

THE HOLE-RIDDLED, TIME-BLACKENED TABLE

On whose plain horizontal top much of modern physiology had its baptism. Here François Magendie demonstrated the properties of the roots of the spinal nerves (1822), and Claude Bernard discovered the function of the spinal accessory nerves (1844), the glycogenic function of the liver (1848), the digestion of fats by the pancreas (1848), animal heat (1851), and the influence of the spinal nerves (1854). In 1861 Claude Bernard gave this historic table to Austin Flint, Jr., who in 1890 presented it to the Army Medical Museum, where it now stands. The accompanying photograph was recently made for the author by Roy M. Reeve, Washington, D. C.

gether and conversed, these men of bronze, the confidences which they communicated to each other were not anent the pleasures of human life."

In France a man's marital difficulties do not prevent him from receiving academic appointments, and Claude Bernard's fame was not all posthumous. As Paul Bert pointed out: "In official life he also attained the highest rank. In 1854, a chair of general physiology was founded for him at the Sorbonne, which in 1868, he surrendered with beautiful magnanimity and grace, to his pupil, Paul Bert. In 1858, he took Magendie's place in the chair of medicine at the Collège de France. Member of the Academy of Science in 1854, he was called in 1868 to take Flourens' seat in the French Academy. Finally in 1869, by special decree, he entered the Senate; he was almost the only member of that assembly whom no one ever thought of reproaching for a nomination which to him was so strange a surprise."

In these days of swift and multiplying changes, let us not forget Paul Bert—the fiery radical who attacked the frauds of the Church of his day as vehemently as Gambetta assailed that evil spirit, Louis Napoleon. After studying and discarding engineering and jurisprudence, he came under the influence of Claude Bernard, and did brilliant work in physiology. He had an eye for the picturesque, and investigated the movements of the sensitive plant, and the change of color in the chameleon. His elementary texts on scientific instruction, his investigations of grafting and vitality of animal tissues, his work on poisons and anesthetics, on respiration and asphyxia, have been overshadowed by his classic researches on air-pressure. Paul Bert divided his allegiance between Claude Bernard and Leon Gambetta, and after the statesman's early and accidental death, Paul Bert was sent to Indo-China as resident-general to Annam and Tonkin. Strange that one of the most cultivated men of his generation should go out among the dwarfish areca-nut chewers with their flattened faces. From the curved mountains of Yun-nan to the Song-Koi valley and the Ba-Be lakes, science had no existence, but Paul Bert prepared to govern the natives according to the principles of Claude Bernard. The tiger-cat and the wild boar thrive, but it is not a land for Arab horses and civilized men. Within seven months of his arrival, the far-sighted resident-general lay dead of dysentery in the delta of the Red River. Now at Hanoi the Paul Bert College stands, challenging comparison with the pagoda of the Great Buddha. Let us remember Paul Bert.

The two chief names in modern French science are Louis Pasteur and Claude Bernard. Pasteur, elected as a free associate of the Academy of Medicine by a majority of one vote, entered an institution where he was often twitted and insulted. By what right, queried the pompous physicians of the day, does this outsider, this mere *chymiaster,* this layman, presume to dispute our convictions? One member of the Academy rejoiced at Pasteur's admission; it was Claude Bernard, who had heard these same physicians declare: "Physiology can be of no practical use in medicine; it is a science de luxe which we do not need." Claude Bernard once whispered into Pasteur's ear: "Have you noticed that when a doctor enters a room, he always looks as if he were about to say, 'I have just been saving a fellow-man'?"

The relationship between Pasteur and Bernard is one of the most beautiful episodes in the history of science. Foster does not mention it in his life of Claude Bernard, but it will be found in Vallery-Radot's life of Pasteur. A mysterious and undiagnosed malady drove Bernard from his laboratory to his vineyard. Bodily pain complicated by melancholia baffled his doctors: Bernard ceased to care to live, and his attendants did not believe that he would survive. Pasteur determined to become Bernard's physician. Interrupting the researches that were revolutionizing medicine, Pasteur read again the works of Bernard and published in the Moniteur Universel a review entitled, *Claude Bernard: the Importance of his Works, Teaching and Method.* In this remarkable tribute, the genius of Claude Bernard was revealed to the public. Pasteur pointed out that

Bernard's Introduction to the Study of Experimental Medicine was a monument raised to honor the method which has constituted physical and chemical science since Galileo and Newton, and which Bernard was endeavoring to introduce into physiology and pathology. "Nothing so complete," asserted Pasteur, "nothing so profound and so luminous has ever been written on the true principles of the difficult art of experimentation. This book will exert an immense influence on medical science, its teaching, its progress, its language even." He heaped high his eulogy, and rendered him such praise as is usually accorded only to the dead. "I seek in vain," said Pasteur, "for a weak point in M. Bernard. It is not to be found. His personal distinction, the noble beauty of his physiognomy, his gentle kindliness attract at first sight; he has no pedantry, none of a scientist's usual faults, but an antique simplicity, a perfectly natural and unaffected manner, while his conversation is deep and full of ideas." Pasteur did not conceal his purpose, and concluded with the hope: "May the publicity now given to these thoughts and feelings cheer the illustrious patient in his enforced idleness, and assure him of the joy with which his return will be welcomed by his friends and colleagues."

Pasteur was forty-four years of age at this time—it was two years before his first paralytic stroke—and while much of his greatest work lay before him, he was already widely renowned. After this magnificent therapy, it is not surprising that Claude Bernard "blushed to the roots of my hair," and in due time returned to his classes at the Collège de France.

Biographically, Bernard has been inadequately treated, even in French. The standard biography of Claude Bernard in our language is the life written in 1899 by the first professor of physiology at Cambridge. Sir Michael Foster was the foremost British teacher of physiology of his generation, and it is not derogatory to say of him that he did not possess the talents of a biographer. His memoir is useful as an exposition of Claude Bernard's methods, but it is not attractive reading; of course, it will be consulted by anyone who is "doing Claude Bernard," but others will not proceed far in its pages. Foster does not refer to the preface which Georges Barral wrote in 1886 when publishing posthumously Claude Bernard's drama. It is a strange neglect that this impassioned tribute has hitherto not appeared in English, and while we cannot give it in its entirety, we will quote it at some length:

> The first time that I had the good fortune and honor of seeing Claude Bernard was on Saturday evening, the 30th of August 1865. It was a surprise and a revelation. The railroad train had come to a stop in Perpignan, bringing from Paris, among numerous celebrities, a deputation from the Academy of Sciences entrusted to represent the Institute of France. The occasion was the unveiling of the first statue erected to François Arago, in his native village of Estagel, situated at a little distance from here.
>
> I had descended from the carriage and as I turned around I perceived a tall figure of a man, whom I did not yet know, going up the steps. He seemed like a vision. I thought I had seen one of the tall modern saints in secular attire, a sort of Vincent de Paul of science. It was very hot, the sun was setting—the ruby-like sun of the Pyrenees spread its flaming splendor over all. His head, with its marble-like features, was uncovered, and a halo drawn by the sunlight of the evening was not lacking.
>
> My adolescent imagination was so struck by the severe beauty and majesty of this celebrated savant, who was then in the prime of his physical and mental powers, that this image always remained engraved upon my memory. I close my eyes and I see it always, as though photographed upon my retina.
>
> I accompanied my father to the celebration, at which he was present as the scientific executor of the illustrious astronomer, whose complete works in 17 volumes he published by Arago's own orders. Claude Bernard during the several days of the celebration showed us great friendship. From that time, now over thirty years distant, dates the affection and veneration which we have always had for this incomparable man.
>
> His drama *Arthur de Bretagne,* which cannot be read without interest and feeling, because of its origin and subject matter itself, revealed the future qualities of the great researcher. The dialogue is emphatic, it rings true; but it is necessary to remember

CLAUDE BERNARD AT SIXTY-FOUR

Statue by Guillaume, erected on the steps of the College of France (February 7, 1886); reproduced in Georges Barral's publication of Claude Bernard's Arthur de Bretagne (Paris, 1887).

that its author was twenty years old and that he wrote this piece under the mitigating influence of the works of Nepomucene Lemercier and of Victor Hugo. How many times, later, having abandoned the tragic muse, Claude Bernard, having wrangled with Nature for her secrets, found himself the medium or the spectator of events stirring in other ways than that which he dramatized.

Read his studies on curare, that terrible poison of the South American Indians which produces absolute insensibility in all the organs and leaves the poisoned human being a living mind, without the means of manifesting itself. You will be driven to the very extreme of terror and pity. Before Claude Bernard's experiments it was believed that death caused by curare was nothing but a sweet slumber. On the contrary, the victim retains all his lucidity. What terrible drama one can imagine! What cruelty of the savage who knows how to steal from Nature this subtle refinement of vengeance!

Listen to Claude Bernard: "Within the motionless body behind the staring eye, with all the appearance of death—feeling and intelligence persist in all their force. Can we conceive of a suffering more horrible than that of intelligence present after the succumbing one by one, of all the organs, which in accordance with the statement of M. de Bonald are destined to serve and find themselves in a way imprisoned alive within a cadaver? In all times, poetic fiction endeavoring to move us to pity, drew before our eyes sensitive beings imprisoned in motionless bodies. The torture which the poet's imagination invented is produced by Nature by the action of the American poison. Only here we may say that reality surpasses fiction. When Tasso depicted Clorinda incarcerated alive in a majestic cypress tree, he left to her at least tears and sobs to bemoan her fate and to move to pity those who made her suffer in wounding her sensitive body."

With such aptitude as a writer, thinker, experimenter and observer, Claude Bernard should not have been a doctor. He was one in fact as little as possible. He became a skeptic at the altar before which he officiated. He realized that the physician's task is almost as difficult as that of the watchmaker of whom it would be demanded that he correct the irregularities of a watch which he is forbidden to open. For what Claude Bernard sought was the very secret of the interior wheelwork; this watch he would break.

would open it with violence rather than permit himself to grope in blind fashion without clearly knowing what he was doing.

Of solemn aspect, somewhat cold as a professor, somewhat wan in his chair, Claude Bernard showed himself incomparable in the laboratory, before the dissecting table. Standing, his head covered with a large hat under which were escaping long grey locks, his neck wrapped around with an immense muffler, grey and black, which he discarded only during the intense summer heat, he could be seen stooping a little, calmly plunging his fingers into the open abdomen of a dog, explaining the object of his researches. He could be seen drawing himself up, running his hands over the bloody entrails of the animal, explaining with a neat gesture and clear words the precise point of his discovery. The experiment ended, he calmly dried his hands and continued to develop his idea, often quoting Descartes whom he studied profoundly and whose fundamental rules he applied.

I am one of those who believes that one should not permit to perish the lesser efforts of great men and because of this I am publishing today the manuscript of *Arthur de Bretagne* which Claude Bernard gave me on Monday, August 14, 1876, about noon, after having delivered at the Museum of Natural History the last lecture of the year on the system of diurnal and nocturnal respiration of plants. He placed it in my hand and said with a sweet smile: "I am giving it to you in memory of our sojourn at Perpignan and Arago, a friend of your father, who rendered me a service in 1849. You may publish it if you wish, but later, at least five years after my death. I have had a vaudeville piece, *Rose du Rhône,* played in Lyons in 1833; I could easily allow my drama to be read. But don't forget to say that it had been rejected with many corrections by Saint-Marc Girardin."

This drama which we have resolved to publish will be read tomorrow at the unveiling of the statue of Claude Bernard. I may add that Claude Bernard did not speak without tenderness of this work of his youth. We have religiously conserved this yellow manuscript in a steel casket like a relic. All which emanates from a genius is holy as his memory is holy. From time to time we make a pilgrimage to the old alley of Commerce Saint-Andre-des-Arts where, at Number 5, for a long time lived Claude Bernard.

At the outset of this essay, we called attention to the modernity of Bernard. Revising the manuscript four years later, we could record how the clock of Time, ticking oblivion for even distinguished men, augments the fame of Claude Bernard. Opening at random medical and scientific journals and books, there is no name we meet so frequently as that of Claude Bernard. Half a century after his death, he leads the vanguard. In 1927, an imperishable monument was raised to his memory in America by the translation of *An Introduction to the Study of Experimental Medicine.* Written in 1865, before the advent of the bacteriological era, it remains to-day and will ever remain, the canon of scientific medicine; it is not only modern, but forward-looking. Even in the midst of modern scientific literature, overwhelming in its copiousness and remarkable for its keen revaluation of established beliefs, Claude Bernard's book pierces like a beacon in the night. Even to those familiar with the most advanced medical thought of the day, it comes as a revelation; its verve, fullness of knowledge, its absolute impartiality, its simple and sagacious search for truth, the impress of a powerful and rational genius bursting forth from every page, combine to make *An Introduction to the Study of Experimental Medicine* one of the most inspiring works ever given to men of science.

In the middle ages there lived in France the abbot of Clairvaux, whose name was Bernard. A man without sin, he must have performed miracles, for did not the sick come from near and far to be healed by his touch? A monk of infinite mercy, he desired to save the world from heresy, for did he not say that unbelievers should be coerced by the sword? Gifted with prophecy while preaching the Second Crusade, did he not assure his followers glorious success? Vast bloodshed and complete disaster for Christendom were the only results, but was not Bernard able to explain that the failure was the result of quarrels over spoils and the lack of piety among the crusaders themselves? In his old age, Bernard died, and became Saint

Bernard. Science does not canonize her workers; she has no prophets, and none of her apostles claim infallibility.

There are problems we cannot answer, there are riddles we cannot read. As we stand before the veil that ever hides the Truth from men, we hear once more the voice of Ernest Renan: "An immense river of oblivion sweeps us onward into a gulf without a name. O abyss, thou art the only God! All here below is but symbol and dream. The gods pass away like men; it would not be well did they last forever. The faith which we have held ought never to be a chain. We have done our duty by it when we have carefully wrapped it round in the purple shroud wherein the dead gods sleep."

Life is a great experiment in physiology, in which we all take part: the unknown holds the protocols, and death writes the conclusions. We do not know where the experiment is tending, nor can we control the outcome. There are gates we cannot open, and impassable roads without a guide-post. Yet we have pressed immeasurably forward; the sable curtain still shrouds us in darkness, but it is no longer so frightening. Often it has lifted, and where once most impenetrable, are seams through which we steal a glance at the mysteries beyond. This has been accomplished, not by denying men the privilege of doubting and investigating, not by appealing to an ancient volume as Holy Writ, but by brushing aside centuries of accumulated traditions by the aid of science. We have mounted our present height by applying the physico-chemical ladder to biology. We linger still on the lower rungs, and the upward climb is perilous, but never was the way so clear. In this frontier-enlarging pilgrimage for the conquest of the secrets of life, there has been no greater pathfinder than Claude Bernard.

(1816–1880)

FERDINAND HEBRA

Hebra was a most remarkable man and in his daily clinics showed a keenness of observation which was simply wonderful. He rarely asked his patient any questions, but a hasty glance would usually enable him to tell more about the case than any one of his students would elicit by a lengthy catechism. Taking the patient's hand in his and looking straight at the class he would say "this man is a tailor" and we soon found that he discovered this fact by feeling the needle pricks on the roughened forefinger. A hatter he would recognize by some peculiar callus on the ball of the thumb and whether a patient was a confirmed beer or brandy drinker he knew by the appearance of the nose and the velvety condition of the skin. He could always guess the age and weight of a patient with unerring accuracy and tell us from what province of Austria he came. He could usually tell about how long an eruption had existed and repeatedly told his pupils not to ask whether an eruption itched but simply to look carefully and note the presence or absence of scratch marks.

One day a patient came in limping, and sat down to remove some bandages from his legs. While patiently waiting, Hebra casually glanced at him and remarked, "This man is a Croat, 55 years of age, has pulmonary tuberculosis and is a tailor by occupation." As he had not had a chance to see or feel his forefinger some of the students smiled at the statement, observing which he quickly asked, "Wouldn't you know he was a tailor? Look at that little strip of drab cloth he has tied around the bandage. Tailors use that stuff for vest linings."

His power of imitation and of vivid description fully equalled his keen observation. One day a deaf mute came to the clinic and Hebra took occasion to refer to what was being done in Vienna for the unfortunate class by means of lip study. He said that children learned in a few months to speak plainly, but that their voices always had a peculiar lack of accent and intonation. He then gave an imitation of their speech and as I had visited the institution the week before I was amazed to note that the imitation was absolutely perfect.

George Henry Fox.

XXIV

FERDINAND HEBRA

[Written on the Centenary of Hebra's Birth]

Only two per cent of the Moravians are Jews, but the family of Ferdinand Hebra helped to make up this percentage. On account of this accident, young Hebra could not become one of the Moravian Brethren, but he became a member of the New Vienna School.

The New Vienna School forms an interesting chapter in the history of medicine, and one of the interesting things about it is that the men who made it famous were not Viennese, but Slavs—with a sprinkling of Magyars and Hebrews. Rokitansky was a Czech, and Skoda, Oppolzer, Hamernik, Lobel, Waller, Schroff, and Czermak were also Bohemians, while Hyrtl, Politzer, and Semmelweis first tasted milk in Hungary.

In 1841 young Hebra stood upon the threshold of his career; he was a graduate of the University of Vienna, was assistant to Skoda, and was in charge of patients afflicted with the itch. The following term Hebra was permitted to lecture, and it was not long before his clinic achieved popularity, for in his speech blossomed that precious double-flower—sympathy and satire.

In 1844 Hebra was twenty-eight years of age, which seems to be a critical year with men of science: The Father of Modern Anatomy was twenty-eight when he overthrew Galenism with *De Fabrica Humani Corporis*:—under his portrait is the famous phrase, *an. æt. xxviii;* Linnæus was twenty-eight when he classified nature in a dozen folio pages; Haller was twenty-eight when he described the function of the bile in the digestion of fats; Bichat was twenty-eight when he became the "Napoleon of Medicine"; Gerhard was twenty-eight when he built a diagnostic fence between typhoid and typhus; Henle was twenty-eight when he put epithelium in modern science; Sharpey was twenty-eight when he increased our knowledge of cilia; Liebig was twenty-eight when he discovered chloral and chloroform; Brodie was twenty-eight when his researches with the woorara poison brought him the Copley medal; Velpeau was twenty-eight when he published his *Treatise on Surgical Anatomy;* Wilhelm His was twenty-eight when he taught us the histology of the thymus; Goltz was twenty-eight when he accomplished his notable work on the mechanism of shock; Cohnheim was twenty-eight when he gave us his monograph on venous stasis; Traube was twenty-eight when his studies in suffocation placed him among the men of science; Ehrlich was twenty-eight when he devised the diazo-reaction in typhoid fever; Hilton Fagge was twenty-eight when he was chosen by the Sydenham Society to translate Hebra for them; and Hebra himself was twenty-eight when he saw the deficiencies in the existing classifications of cutaneous diseases, and decided to compile a classification based upon the pathological anatomy of the skin—with a few hints from his friend Rokitansky.

In the following year, when Hebra's system was published, the prevailing classifications became antiquated—just as previous treatises on embryology took on a tinge of superannuation when Wolff's *Theoria Generationis* appeared. A perfect classification of the dermatoses, whether based upon their etiology, pathology or symptomatology, is a dream that will never be realized. In the medical millennium, when we know the cause of cancer, and the prophylaxis of poliomyelitis, and the therapy of pneumonia,—even then the classification of diseases of the skin will be faulty and criticizable. That is why some of the best informed of modern dermatologists, like George Thomas Jackson, employed no classification at all, but in their text-books simply arranged the diseases in alphabetical order—beginning with acantholysis bullosa and ending with zoster. Hebra's classification is not ideal, but twelve years

HEBRA

later when he had seen 80,000 cases, he found little to change in his system, and it has formed the basis of practically every subsequent classification—and these have been as numerous as alleged discoveries concerning pellagra.

Before Hebra, the greatest dermatologists were English and French—and the Germans translated their works and copied their plates. During the first half of the nineteenth century, the masters of cutaneous diseases were Willan, Bateman, Erasmus Wilson, Arthur Jacob, and Alibert, Biett, Rayer, Devergie, and Cazenave. After Hebra, England produced her McCall Anderson, Radcliffe Crocker, and Jonathan Hutchinson, and France gave us Brocq, Darier, and Sabouraud, but we have come to look upon dermatology as a German province. It was Ferdinand Hebra who captured this vast domain, and enlarged its boundaries. In 1845 the star of dermatology shifted to Vienna, and has hovered there ever since.

In every age the quarrels of authors have added zest to literature, but even scientists have indulged in a little bickering: Sylvius bawled throughout Europe that Vesalius was a madman; Jesse Foot informed the public that John Hunter was an ignoramus; the Monros fought with nearly all their contemporaries; Haller saw no merit in the work of Kaspar Friedrich Wolff; Ludwig Traube and von Frerichs did not speak to each other; and the gentle Gross aimed a poisoned shaft at Hebra.

"Hebra, the dermatologist," wrote Professor Gross, "had hardly half a dozen attendants; he is a short, thick-set man, with dirty fingers and a dress a good deal the worse for wear; in a word, he is anything but neat in his person; and during the hour I spent in his ward I did not become at all pleasantly impressed by his manner or his appearance. Of his skill as a diagnostician everybody must be convinced, seeing how great is his experience; but, from what I have seen of his writings, I have no hesitation in saying that he has done more than any living authority to confuse the study of skin diseases. His treatment, moreover, of many of those affections seems to me to be too purely local, or in other words, not sufficiently addressed to the constitution, upon the derangement of which they so often depend."

The deeds of Samuel D. Gross were "all crowned by the milk-white flower of a stainless life," but here he was guilty of writing impressions while-you-wait; he saw Hebra for an hour, and damned him forever. There is some justification for Gross's complaint that Hebra regarded cutaneous diseases as local rather than constitutional, but this did not prevent efficient treatment. In fact, it was a distinct advance over the method then in vogue of general treatment for all skin diseases, for Hebra paid attention to the nature of each case—and got real results. Moreover, Hebra called attention to the fact that it is quite a mistake to suppose that the action of remedies applied to the diseased or healthy skin is necessarily merely topical and not general. He pointed out that the contagia of various diseases can be introduced through the skin, and that it is equally adapted to absorb medicinal agents, and to admit them into the circulation, even while the epidermis is intact—as can be shown during the external use of tar, of iodine, or of the mercurial preparations. He maintained that with the exception of caustics all remedies which are brought into prolonged contact with the skin are absorbed by it, and taken up into the fluids of the body.

Some of Hebra's remedies are prescribed to-day: his diachylon ointment for eczema still melts on many skins.

Hebra became a benefactor of mankind when he insisted upon hydrargyrum in lues. To-day mercury in syphilis is the specific by whose great deeds we seek to confound the skeptic in drugs. But to the foremost syphilologists and syphilographers of Hebra's time, mercury was anathema. J. K. Proksch, although he knew so well the history of syphilis, was an anti-mercurialist, and Baas tells us that J. Hermann was such a fanatical opponent of the mercurial treatment of syphilis that he sought to have its use prohibited by law.

But Hebra lived in the Golden Age of Therapeutic Nihilism, when Skoda, Hamernik and Dietl expelled materia medica from medicine—and Hebra was Skoda's pupil. Often he pretended to treat a disease, when he really only observed its course—and observed that the lesions healed of themselves. But even in the days of John Hunter it was known that in dermatology the most rational therapy may be no therapy: A young man had a pimple on his leg to which an ointment was applied; the eruption spread and more ointment was applied; and the entire leg became covered with pimples. John Hunter was then asked what should be done. "Nothing." "How is that?" "Can anything be easier: do nothing to the leg," explained Hunter. "Then the stocking will stick to it," was the objection. "Let no stocking be worn." The advice was followed, and the leg dried up and healed. What dermatologist cannot recite similar cases from his own experience? Skodaism should not be our ideal, but it is immeasurably preferable to meddlesome medicine.

The writings of Hebra are characterized by simplicity, lucidity and judiciousness. Here is a passage that pleased our own wise Piffard:

> Researches made with care have demonstrated that women, young or old, who suffer from acne rosacea usually suffer from menstrual disorder. Of the exact nature of the trouble we are often obliged to remain in ignorance, in consequence of the frequent impossibility, or at least difficulty, of making a direct examination of unmarried women, or of obtaining from them a history of any value. I will simply recall, as example, how rare it is to obtain satisfactory replies when you ask a young woman if her menstruation is regular or not, whether it is scanty or profuse, or whether painful or not. According to my experience she will at first reply that she is all right in that respect, while later, if she is questioned with some persistence, she will admit that it is entirely otherwise. This is quite natural, and should be attributed rather to the manner in which the questions are put, than to a desire on the part of the patient to deceive. A question asked in general terms pre-supposes, if a correct and exact reply is to

be given, that the patient herself knows exactly how and when the menstrual epoch should appear, how long the flow should last, and what should be the proper intervals. This is evidently too much to expect of a young girl. The best way is to ask direct and precise questions, for instance, "When were you unwell last?" "How many days did the flow continue?" "After how many days does it usually return?" "Is it preceded by or accompanied with pain?" "Do you suffer from the whites before, after or during the interval?" "What is the quantity, nature and color of the discharge?" "When do you next expect to be unwell?" etc. The result of an inquiry pursued in these terms will demonstrate how imperfectly acquainted the generality of women are with these matters, but it is the only means by which we can hope to obtain the information we need, and which is so indispensable to their welfare.

Even when discussing therapeutics, Hebra was fair-minded, slow-pulsed and impartial, as the following excerpt will demonstrate:

> There is another point also, in which we are opposed to our predecessors and to many of our contemporaries, and that is with reference to the necessity for using in the cure of chronic skin-affections remedies which are supposed to be purifiers of the blood. We have never seen the effects which are ascribed to them by some authors, produced either by the long-continued administrations of laxatives and drastics, nor by decoctions of woods, nor by vegetable juices. Again, the internal use of antimonials, baryta, graphite, anthracocali, or sulphur; or again of cantharides, mezereum, viola tricolor, dulcamara, Roob Laffecteur, or sirop de Larrey, has been invariably unattended with the hoped-for success, and therefore we cannot recommend to anyone the employment of these agents. On the other hand, arsenic has proved in our hands a useful internal remedy, though we cannot praise it to the same extent as do Hunt and Romberg. And we have also seen good effects produced by the preparations of mercury, of iodine, and of iron, by the oleum morrhuae, by the bitters, and the vegetable and mineral acids; and lastly, by all those remedies which are indicated in particular cases by the presence of dyscrasiae, and which would be prescribed equally, although the general affection were running its course unattended by any local disease of the skin.

Most members of the New Vienna School were of the opinion that medical wisdom originated with themselves, and thus they did not study the past, but Hebra was an exception—in his text-book he devotes about thirty pages to the history of scabies. And as he gave almost as much space to the treatment of eczema, it seems that Hebra was not a typical representative of the school which he helped to render illustrious.

Early in his career, Hebra described seborrhea congestiva, but later agreed with Cazenave that the affection ought to be ranked with lupus, and for the sake of distinction it was named lupus erythematosus. Under the name of eczema marginatum he described a special form of eczema which he first found among shoemakers, but afterwards observed that it was not confined to them. He gave us the initial description of impetigo herpetiformis, and wrote the chief account of lichen ruber. Erythema multiforme is still known as Hebra's disease or Hebra's erythema, just as a certain type of pityriasis rubra is called Hebra's pityriasis, and true prurigo is Hebra's prurigo.

Hebra was intimately connected with the noblest and most tragic figure of the New Vienna School. When Semmelweis announced that puerperal fever was a septic infection, Hebra was editor of the *Journal of the Medical Society of Vienna.* He was only two years older than Semmelweis, but he already had a reputation to lose, and he staked it by calling Semmelweis a second Jenner. Semmelweis was the obstetrician at Frau Hebra's next confinement, and Semmelweis and Hebra met again in the Academic Legion in the year of revolutions. In the battle which Semmelweis waged for his Doctrine, he had always the support of Hebra. And in the last year, when the emotional Hungarian was driven to desperation by his enemies, upon Hebra fell the terrible duty of bringing to the madhouse the man whose name he had once linked with that of Edward Jenner.

Hebra was an admirable teacher and trained several pupils who rose to eminence: Isidor Neumann, Carl Heitzmann, Heinrich Auspitz, Gustav Wertheim, Philipp Pick, and Eduard Lang. But Hebra was fortunate—his mantle did not descend upon strange shoulders. None of his pupils achieved greater distinction than his son, Hans von Hebra, and his son-in-law, Moriz Kaposi, whose real name, by the way, was Kohn—and like the Kohn in Romain Rolland's *Jean Christophe,* he changed it. Kaposi was a dermatologist of the first rank, and well deserves an essay to himself, but in lieu of that we will quote from Fielding Garrison, whose sketches are like active-principle granules, for he compresses a biography into a sentence:

> Hebra's work was completed and extended by his son, Hans von Hebra (born 1847), of Vienna, who wrote a text-book on skin diseases in relation to diseases of the entire organism (1884), described rhinoscleroma (1870) and rhinophyma (1881), and by his pupil, the Hungarian Moriz Kaposi (1837–1902), who completed the elder Hebra's text-book, besides writing one of his own (1879), and described pigmented sarcoma of the skin (1872), diabetic dermatitis (1876), xeroderma pigmentosum (1882), lymphoderma perniciosa (1885), the various forms of lichen ruber (1886–95), and ultimately put Hebra's impetigo herpetiformis upon a definite footing (1887).

In all ages and in every country, the dominant race invariably oppresses the weaker—this is an ineradicable defect inherent in human protoplasm. Fair play has no antibodies for the incurable disease of race prejudice. The demand for uniformity—that we all look alike, dress alike, think alike, be alike—has made the world a wearisome place. Man's insistence that his neighbor be of the same creed and color as himself, has turned the earth into a charnel-house. The wars of religion—what oceans of human blood have been shed for competitive myths! Civilization will never blossom on this planet until we realize that we are all children of Mother Earth, and the word "foreigner" is erased from the vocabulary of humanity.

Concerning the people known as the Jews, how much of the prejudice against them is of a criminal nature, how much is justified by their own behavior, and how much is fictional—simply the well-known Hebrew propensity for belly-aching—is a problem often discussed and never settled. It is said however, that in the medical circles of Vienna there exists much prejudice against the Jews. Schnitzler's *Professor Bernhardi* seems to be founded upon fact—Arthur Schnitzler was a physician before he learnt the lure of literature. Even so well-liked a teacher as Professor Nothnagel lost his popularity when he tried to combat the anti-Semitism of the students; the classes rioted, and for a time all the courses in medicine were suspended. It therefore speaks well for the personality of Hebra that for forty years he reigned in Vienna as the undisputed potentate of Hautkrankheiten.

In the summer of 1880, the master made his last diagnosis; after that, those who were afflicted with skin disease had to see Kaposi. A correspondent described the burial in a letter to the Cincinnati Lancet and Clinic: "The funeral of Hebra was an event to be remembered in Vienna. A procession one mile and a half in length followed the remains to their resting-place. A great multitude rendered the streets almost impassable. Eager to do him homage, laymen, students, scientists, and nobles, all commingled, paid by their presence that silent tribute which is more eloquent than words. He lies buried by the side of the great Rokitansky."

This is the centennial year of Hebra's birth. A century is sufficient to swallow up most human beings. Millions were born in 1816—how many are remembered in 1916? But dermatologists—and who amongst us is not something of a dermatologist?—can celebrate the centenary of a name that will not be wiped out by the flood of time: for dermatology knows no greater name than that of Ferdinand von Hebra.

(1818–1865)

IGNAZ PHILIPP SEMMELWEIS

Permit me further to express the holy joy with which I studied your work, *Die Aetiologie*. In the course of a conversation on the subject with a colleague here, I felt myself compelled to declare: This man is a second Jenner; may his services receive a similar recognition and his efforts bring him the enjoyment of a similar satisfaction. . . . It has been vouchsafed to very few to confer great and permanent benefits upon mankind, and with few exceptions the world has crucified and burned its benefactors. I hope you will not grow weary in the honorable fight which still remains before you.

KUGELMANN: *to Semmelweis.*

XXV

IGNAZ PHILIPP SEMMELWEIS

The great Lying-in Hospital of Vienna is divided into two sections: the first obstetric clinic is for medical students, and the second for midwife-pupils.

The medical profession has often been accused of overdrugging, but the Vienna School of the nineteenth century had no materia medica. This school produced no therapeutists: it forgot that a physician should sometimes cure. "Doctor, what medicine shall I take?" asked the invalid who had been treated merely as an object of scientific investigation. "Oh," exclaimed the Viennese medicus, as if surprised at the question, "that is immaterial." If the sufferer still insisted on treatment, he was given a standard prescription which the apothecary read as follows: "℞—A little bitter-almond water mixed with considerable common water, sweetened and fortified with syrup."

Skoda was enthusiastic in making diagnoses, and Rokitansky in performing autopsies—and if the diagnosis and the autopsy agreed, the patient was not supposed to complain. The dissecting-room was their temple, where they devoutly prayed to be admitted to the inner mysteries of diseased organs. The cadaver was considered the noblest work of nature. The subject of pathologic anatomy was immensely enriched, but little was done to heal the sick or save the dying. "Our ancestors," said Professor Dietl, "laid much stress on the success of their treatment of the sick; we, however, on the result of our investigations. Our tendency is purely scientific. The physician should be judged by the extent of his knowledge and not by the number of his cures. It is the investigator, not the healer, that is to be appreciated in the physician."

The students whom we see in the First Clinic have just come from post-mortem examinations, and are waiting for an instructor to take them to the obstetric cases. They have washed their hands with a squirt of water, and are now drying these organs by blowing on them, waving them in the air, or sticking them in their pockets.

"Oho, Marcus, how would you like to have a sweetheart like that?" asks a future accoucheur, indicating a woman with a meteoric abdomen.

"Why, Franz, that looks like the girl you were walking with last night."

"Oh, you old bugger! I was with your own sister the whole evening."

"You lie! Lilly said she was going out with a gentleman, so it couldn't have been you."

"I swear that I and no other—but Heavens! how the Fräulein can drink! Tokayer—a bottle; Pfaffstättner—a bottle; Gumpoldskirchener—a bottle. I have no money left. Loan me a few gulden, will you?"

"So you can make my sister drunk? Why don't you take the girl to church?"

"Stop that squabbling about Fräulein Lilly, fellows; here comes—"

The teacher enters the clinic, but the amused smirks of the students have already been succeeded by studious looks. Their instructor is Professor Klein's assistant; he answers to the German name of Dr. Semmelweis, but he is a true Magyar, born in Budapest, and he speaks German with an accent and writes it with a hitch. Although he is getting bald, he is still in his twenties: only a few years ago he lived and laughed in the Josefstadt—the Latin-Quarter of Vienna. He is genial, sympathetic, soft-hearted; the quintessence of goodness is revealed in his open smile.

He leads the way through the wards, pointing out the interesting cases, and directing physical examinations to be made.

Suddenly he stops; his brow contracts on the bridge of his nose. Before him lies a young mother exhibiting the symptoms of puerperal fever. He remembers her—three days ago he delivered her of a healthy infant. Parent and child seemed to be doing well, but now the curse of the lying-in hospital smites them. Unlike Jules Clement, Semmelweis is not accoucheur to Mlle. la Valliere, or any other royal mistress, but every servant-girl entrusted to his care he treats as tenderly as if she were a queen upon whom rested the hopes of a dynasty. For a moment he forgets his students and gazes with compassion at the stricken woman. A cold wave sweeps along her spinal cord, her pulse gallops, her skin is hot and dry, her breathing short and hurried, her countenance sunken and anxious, and at night she mutters in a lethal delirium. She is sick, and next week she will be dead.

The Assistant dismisses the students from his clinic, but he cannot banish the subject from his mind. He goes out, hurries along the Haupt-Allée, past the superb chestnut trees, the epauleted officers, the prancing horses, the beautiful ladies.

He walks unheeding, while all the time his ear-drums half burst from the loud queries that ring through his head: Why do they die? What is childbed fever? How does it enter the lying-in chamber?

He has read all the books he could find on the subject, and the various theories of distinguished obstetricians flit through his mind: "It is due to the milk," says Boer. "It is epidemic," announces Klein. "It is caused by lochial suppression," thinks Smellie. "Miasma is responsible for it," declares Cruveilhier. "It is a gastric-bilious disturbance," writes Denman. "Its etiology is found in peritonitis," argues Baudelocque. "Erysipelas of the bowels is the predisposing factor," opines Gordon.

The conflicting notions fill Dr. Semmelweis with despair. Who knows which is the correct solution, or if any are true? We grope in darkness; all is chaos and doubt; nothing is certain—except that the number of women who die in child-birth is appalling. In the holiest hour of her life the woman is beaten down by an unknown hand. And the physicians who should save her, stand helplessly by—discussing etiology.

The young doctor thinks and thinks. He is a favorite of Rokitansky, and in the early morning, before his duties in the hospital begin, he examines and operates on the females who died from puerperal fever, or any diseases peculiar to women. But nothing that he has ever observed can furnish an inkling of the truth.

What mystery of medicine is this which carries off women without a determinable cause? Pregnancy is not a nine months' disease; it is natural, and healthy puerperants should not succumb. And here is the strange part of it all: the maternity hospital is divided into two divisions: the first for medical students, and the second for midwives. The conditions are identical in each, and yet so many more die in the first division than in the second. The first clinic has long had a bad reputation, and therefore the second ward is always more crowded, and yet the mortality continues to be higher in the first. Why should this be?

Fear of the first division is claimed to have something to do with the matter. But a psychic state can never produce such anatomical changes as are seen in puerperal fever.

They say the women are ashamed to undergo parturition in presence of the men, and therefore die from modesty. But how can a condition of mind cause a gangrenous endometrium?

They speak of epidemic influences. But why should an epidemic spare one clinic and attack another, when both are under the same roof? Besides, when the fever rages at its worst in the hospital, the women delivered in their homes are not affected more than usual. An epidemic is not limited by walls: cholera spreads over a wide area.

It is said that so many of the women die because they are unmarried and have been seduced. But this cannot explain the difference in the mortality of the two divisions, since exactly the same class of patients is admitted to both clinics. Moreover, nature never feels outraged because the mother does not possess a marriage-ring.

It is argued that the medical students examine the women in a rougher manner than do the midwives, and thus cause injury which results in death. But certainly a uterus enlarged by a fetus can tolerate the most ungentle index finger.

They say the ventilation is wrong, but the same method of allowing air to enter is employed in both divisions.

It is all nonsense to talk about the diet, the warming, the washing. The same caterer supplies food to both divisions; the same washerwomen clean the linen of the first and second clinics.

The women surprised by labor in the streets, who give birth to children on door-steps and under arch-ways, though the day be cold or the night stormy, are not attacked by puerperal fever. Why, women of the country, gored open and delivered of their seed by the horns of maddened bulls, have a better chance of life than the pregnant female who comes to lie in the First Obstetric Clinic of Vienna's Maternity Hospital.

Thus musing, the distracted Assistant finds he has walked far out—to the Central Cemetery, where reposes the illustrious dust of Beethoven and Mozart and Gluck and Schubert. But Semmelweis is not in a mood for melody. The subtle and resistless onset of puerperal fever, the vacant chair by the desolated fireside, the straight road from the marriage-bed to the dead-house, the husband undone and a baby for a salaried wet-nurse—these are the discords which afflict the sensitive Hungarian who has taken the vow of Hippocrates.

He has reached the environs of Vienna. In the distance, seeming to come from the left bank of the Danube, in the direction of the battlefield of Wagram, he hears the note of a church-bell. He starts disagreeably at the sound. He has heard that doleful tone too often of late. At the Clinic, when the end draws near, and the priest bears the last sacrament to her who bids the world farewell, a bell is rung to mark the passing of a soul. And this frequent, solemn tolling jars with strange effect the nerves of the doctor.

He turns homeward: the problem yet unsolved, still in the grip of a hideous malady. Everywhere is endless confusion; only this much proven: they die, they die, they die. Again the bell clangs: it is an exhortation, O Semmelweis! to be clear of vision and find the source of childbed fever, so the mothers of the race may conceive in safety, and breasts ripe for nursing will not shrivel till the love-fruit takes its fill.

In the early spring of 1847—the same year that Oliver Wendell Holmes became Professor of Anatomy at Harvard—Semmelweis went for a short vacation to Venice, but unlike Byron, he did not lean back in a gondola with voluptuous languor, while a black-eyed Venetian girl opposite read the tales of Boccaccio.

On the twentieth of March he returned to Vienna, and a few hours later was at his post, prepared to resume his duties with renewed ardor. But the first news he heard was the sad fate of Kolletschka, a friend whom he highly esteemed. Kolletschka was Professor of Medical Jurisprudence, and while performing a post-mortem examination in a medico-legal case, was accidentally pricked on the finger by the knife of a pupil. Through the tiny stab-wound the poison from the scalpel's tip entered, and inflammation ran wild in the Professor's body: lymphangitis, phlebitis, peritonitis, pleuritis, meningitis. Blood-vessel and lymph-channel conveyed the infection to his eyes, and Kolletschka was sightless and lifeless before Semmelweis returned from feeding the pigeons that fly below the golden horses of St. Mark.

As Semmelweis listened to the details of the case, to him as to Porphyro on a sweeter occasion, "a thought came like a fullblown rose, flushing his brow, and in his pained heart made purple riot." Lymphangitis, phlebitis, peritonitis, pleuritis, meningitis—these were the symptoms observed in women who perished of puerperal fever. Semmelweis saw that Kolletschka and the puerperal women died from an identical cause—from septic infection, from poisoned cadaveric material absorbed by the vascular system. Puerperal fever was not a malady unique in nature—it was simply a form of pyemia!

Now it became clear why the mortality of the first obstetric clinic was so much higher than the second: the instruction of the midwives did not include work on the cadaver; therefore they did not often come into contact with decomposing organic matter. But pathologic anatomy was all the rage in Vienna, and the medical student had an overdose of dissection. From the dead-house they came to the labor-ward, and with hands to which the cadaveric particles still adhered, poison lurking behind every finger-nail, they examined the pregnant, parturient, and puerperal women. And the gaping genitals freshly wounded by travail, the denuded surface of the vagina, the fissures about the fourchette, the lacerations near the mouth of the womb, easily sucked up the noxious virus that spelled disaster and death.

A little later Semmelweis declared that not only decomposing cadaveric matter, but that putrid matter derived from living organisms, and even the atmosphere when overloaded with foul exhalations, may produce the dreaded septicemia. After this, the students who came to the First Clinic found a new rule: before touching a woman they must disinfect their hands with a solution of chlorinated lime. This was the introduction of antisepsis into obstetrics. Immediately the slaughtering of the mothers was lessened, and soon—for the first time in the history of the Vienna Lying-in Hospital—the mortality in the First Division fell below that of the Second Division. A chunk of chloride of lime, upsetting a hundred theories, accomplished this miracle. Now to proclaim the Doctrine to the whole world!

Semmelweis had reason to congratulate himself: the next day the three greatest men in Vienna were his disciples. Skoda referred to his discovery as one of the most important in the domain of medicine. Rokitansky at once accepted his new etiology of puerperal fever. Lest it be deemed strange that a man whose days were spent in the dissecting-room should be so alive to new ideas, we must say that Rokitansky kept sweet and sane by memorizing Kant and marrying a singer. Hebra, who knew so much about itch that we call him the Father of Modern Dermatology, was editor of the *Journal of the Medical Society of Vienna,* and wrote a couple of articles in which he linked the name of Semmelweis with that of Edward Jenner. In return for the compliment, Semmelweis acted as accoucheur in Frau Hebra's next confinement, and his skilled and sterilized hands delivered the good woman in safety.

But not many were as clear-headed as this triumvirate, and misoneism—that insidious inertia of the mind which makes mankind averse to innovation—soon asserted itself in clinic, hospital and lecture-room. Semmelweis awoke and found himself famous—and hated.

At this period, however, something happened in Europe which caused even Semmelweis to forget puerperal fever. A nobler fever attacked Mother Earth—the fever of 1848. This was the year in which barricades rose like magic to the sound of the singing of the Marseillaise; the year of Mazzini and the Roman Republic; the year of Garibaldi and his red-shirts; the year of flying popes and abdicating emperors; the year of overturned thrones and angry peoples; the year when the workingman's pike was aimed at the monarch's scepter; the year of endless courage and divine defiance; the year of young blood and new life.

Knout-cursed Russia did not tug at her chains, but every other nation leaped up in fiery revolt. Of course, Austria was all turmoil, for Austria, the lengthened shadow of Metternich, was the chief oppressor of western Europe. The university students of Vienna, cursing the prince's cruelty, broke into Metternich's home, and drove the old monster over the continent.

Professors and pupils, physicians and lawyers, formed an Academic Legion. Ferdinand Hebra, though more accustomed to dermatologic eruptions than to political ones, enrolled as a member. Ludwig Frankl, the Jewish poet-physician, joined the students; he wrote *Die Universität,* which twenty composers set to music, while half a million copies went through Austria and Germany. Ernst Krackowizer, the first person in Vienna on whom the anæsthetic properties of chloroform were tried, unsheathed his sword for freedom. And when the reactionary Professor Klein walked through his clinic, whom should he see arrayed in the uniform of the revolutionary Legion, but his assistant, Dr. Ignaz Philipp Semmelweis. He could hardly recognize him at first because of the broad hat with the waving plume. And what was it he held in his hand—a scalpel or a sword? Hippocrates was supplanted by Louis Kossuth.

In Berlin the worthiest sons of Æsculapius acted in the same way. Rudolph Virchow was deprived of his posts by the Prussian authorities, and another turn of the fickle wheel of fortune might have snuffed out his life. Physicians have not yet discovered the drug that ensures perpetual youth, and few who warmed their hearts in the sacred blaze of 1848, are now alive. Yet we all know one physician who was then in prison for liberty's sake, and still lives and practices his profession, and has recently become the President of the American Medical Association: Ave Magister, Abraham Jacobi!

Magyarland, under the brilliant leadership of Kossuth, was gaining its independence. But the strong Czar poured his armies into Austria, and a hundred thousand armed Russians trampled out Hungary's freedom. The flame of rebellion flickered low, and 1849 was the year of reaction. The barricades were razed to the ground, the Marseillaise was sung no more, the aspirations were quenched, the monarchs returned, a host of revolutionaries—those who escaped death and dungeons—flocked to England and America, while several who were not too deeply compromised sought to resume their former positions.

Semmelweis came back to the Obstetric Clinic, and found a new proof of the truth of his doctrine: during the month of

March, 1848, such excitement had prevailed in Vienna, that the parturient women in the lying-in hospital were practically neglected, and that was the only month in which not a single death or sickness occurred.

Semmelweis and his companions decided to carry on their propaganda, not through pamphlets or the press, but by private letters addressed to various teachers of midwifery.

Professor Michaelis of Kiel, whose work on the *Obliquely Contracted Pelvis* is still famous, received one of these letters and was impressed by the contents. Michaelis, a conscientious man, was much worried over the prevalence of puerperal fever in his clinic. In fact, not being able to cope with the situation, he found it necessary to close the hospital for a time. He now introduced Semmelweis's method of chlorine disinfection, watching results, and the outcome was this: no more puerperal fever. Michaelis was profoundly grateful, and regarded Semmelweis as a benefactor of the human race.

A scourge abolished! The excellent professor hummed in satisfaction, but a shooting pain broke off the song on the penult of a word. His niece, his beloved niece—what dreams she had when she felt her babe move within her—already in anticipation she saw her child climb to distinguished heights—how anxious she was to sew a coverlet with which to warm the little stranger on his first appearance—and she had trusted her uncle—so innocently she had looked up in his face and put her doubly-precious life in his hands—and with these same hands he had murdered her—with these stained hands he had conveyed puerperal fever to her, and her dreams were done—she wrapped the sheets of the childbed around her as a snowy shroud, and said Good-by, and died. The warm-hearted Michaelis recoiled at the unlivable horror of the thing. Something sticky seemed to cling to his fingers. These fingers killed her, and she did not even reproach him. But how the keen voice of remorse breathed hot into his ear. Michaelis rushed from his house. His darkened eyes saw nothing, but he heard a train with snorting breath rumble over the parallel rails. He advanced feverishly, threw himself upon the trackway, and when the locomotive passed there was only a book on *The Contracted Pelvis* to keep alive the name and fame of Professor G. A. Michaelis of Kiel. So the gospel of Semmelweis was sanctified by a martyr's blood.

Semmelweis was likewise forced to admit that he himself had been the harbinger of death in many households: "When an assistant took special interest in pathologic anatomy, and made many post-mortem examinations, the mortality was high. Consequently must I here make my confession that God only knows the number of women whom I have consigned prematurely to the grave. I have occupied myself with a cadaver to an extent reached by few obstetricians. However painful and depressing the recognition may be, there is no advantage in concealment; if the misfortune is not to remain permanent, the truth must be brought home to all concerned."

Correspondence was also entered into with Simpson of Edinburgh, who introduced anæsthesia into obstetrics the same year that Semmelweis introduced antisepsis. Simpson read the letter in haste, and replied with a Scotch accent: He knew without being told how filthy the maternity hospitals in Germany and Austria were; he knew that the high mortality was due to the criminal carelessness of placing a healthy lying-in woman on the same bedclothes and linen in which a parturient woman had just died; if Semmelweis and his friends would take the trouble to read British obstetric literature they would see that Englishmen had long been aware of the contagious character of puerperal disease and had employed chlorine disinfection for its prevention.

From the above it will be seen that Professor Simpson confused the English theory of the specific contagiousness of puerperal fever—a disease communicated by the sick puerperant to the healthy one, or transmitted by the physician who had confined a woman suffering from the malady—with the

Semmelweis doctrine of its causation by the absorption of putrid matter from a living organism or cadaver, producing a pyemic blood-dissolution.

It will be recalled that these English opinions were copied and adopted in 1843 by Oliver Wendell Holmes, in his immortal essay, "The Contagiousness of Puerperal Fever." Yet in Siebold's standard *History of Obstetrics* there is no mention of Dr. Holmes. Such accidents seem liable to occur: Baker Brown actually wrote an historical sketch of ovariotomy without referring to Ephraim McDowell. It is true Holmes did not devote much time to puerperal sepsis. He wrote his one essay on the subject, and set it adrift in a quarterly medical magazine which suspended publication within a year. But the man and his work could not perish—especially as the eminent Professor Meigs denounced him with the same virulence that he opposed Simpson's use of chloroform in labor. There is no passage in medical literature more frequently quoted than Holmes' concluding appeal: "The woman about to become a mother, or with new-born infant upon her bosom, should be the object of trembling care and sympathy wherever she bears her tender burden, or stretches her aching limbs. The very outcast of the streets has pity upon her sister in degradation, when the seal of promised maternity is impressed upon her. The remorseless vengeance of the law, brought down upon its victims by a machinery as sure as destiny, is arrested in its fall at a word which reveals her transient claim for mercy. The solemn prayer of the liturgy singles out her sorrows from the multiplied trials of life, to plead for her in the hour of peril. God forbid that any member of the profession to which she trusts her life, doubly precious at that eventful period, should hazard it negligently, unadvisedly, or selfishly."

A closer examination of the subject convinced Simpson that the English and the Semmelweis etiology were not identical, and since he was J. Y. Simpson, he acknowledged his mistake. From that time on, aided by his well-known assistant, Matthews Duncan, he preached the truth regarding puerperal sepsis, and it was due chiefly to the efforts of his school that British obstetrics outstripped and long outranked the continental tokology.

About this period, an honor was conferred upon Semmelweis. Dr. Karl Haller, an influential man, a director and senior physician of the General Hospital, suggested that Semmelweis be invited to address the Vienna Medical Society on his experience with puerperal fever. The motion was adopted, but Semmelweis voted in the negative. In truth, he had never spoken to an audience, and the mere thought of it gave him stage-fright—an evil which a solution of chlorine could not remove. Finally he was prevailed upon to appear, and he produced an excellent impression. The discussion that followed was certainly pleasing to Semmelweis. Rokitansky, who presided, spoke in his favor; brave Chiari—son-in-law of Klein—voiced his approval; Helm and Arneth called the young discoverer a benefactor, while Skoda, Hebra, and Haller applauded.

It was a great triumph for the humble assistant, but it aroused his enemies to action. Rosas cursed him; Klein frowned heavily when he met him; Scanzoni—the snake of midwifery who rattled his fangs also at Simpson—poured venom at him; Bamberger attacked him; Kiwisch insulted him; Lumpe laughed at him; Seyfert spat at him.

By this time Semmelweis's assistantship had expired, and he applied for an extension of two years more, as his predecessor in the First Clinic and his colleague in the Second Clinic had successfully done. But the authorities were against Semmelweis. It was not forgotten that he had served in the Academic Legion. The stupid Klein took his revenge; his pursed-up lips meant, "I want to be rid of you." Semmelweis then petitioned to be appointed privat-docent of midwifery. After a rather long wait—from March, 1849, till October, 1850—he received the position, but with galling restrictions; he could not grant certificates of attendance like other docenten, and he could demonstrate not on the cadaver, only on the manikin. Semmelweis was an emotional man. He was a scientist, but with the artistic temperament. He was terribly enraged, and made up his mind to shake the dust of Vienna from his feet. He acted unreasonably, and did not call upon Rokitansky; he did not bid farewell to Hebra; he did not shake hands with Skoda. He simply packed up his belongings, and started for Budapest. Ignaz Semmelweis is a type that Tragedy loves to mark as her own: intense, impractical, uncompromising. Too unworldly to look after his personal interests, too honest to make terms with popular falsehood, he was predestined for the road of bitterness, and the crown of thorns awaited him.

Twelve years ago, as a pleasant youth of nineteen, Semmelweis had left Budapest to enter the University of Vienna. Now he came back to his birthplace, immortal but unsuccessful. His home-coming was not a happy one. His parents were dead; his brothers, who had taken their share in the revolution of 1848, were refugees; there remained to him only one brother, who was a parson, and one sister, who was married.

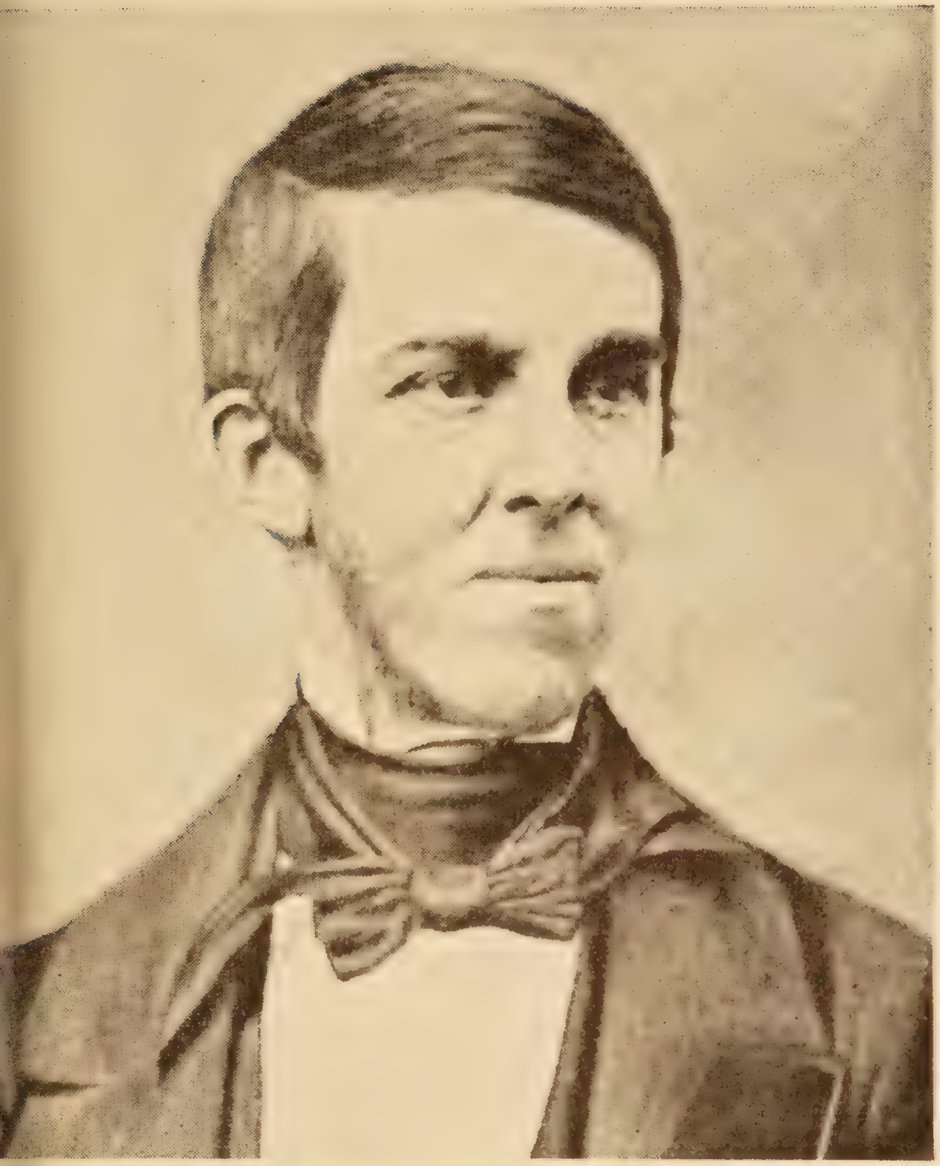
The sight of houses and landmarks intimately known in former days brought back a thousand recollections of boyhood, and he could but smile that so many trivial and even silly incidents should crowd upon his memory. After all, he was not sorry to leave Vienna, and he whistled a snatch from Petöfi, but stopped in amazement to look at the majestic Suspension Bridge which had been completed the year before by the English engineers, Tiernay and Adam Clark. Then he strolled reminiscently through the street where his father had kept a shop.

Semmelweis felt a subtle sympathy for his country, which, like himself, had been conquered by the powers of darkness: stabbed by Windischgratz, hanged by Haynau, knouted by Nicholas. Only a year before Semmelweis returned to Budapest, Louis Batthyani, the distinguished Hungarian patriot, had been caught there, court-martialed, and shot. The prison-odor still clung to Balassa, the professor of surgery. Sem-

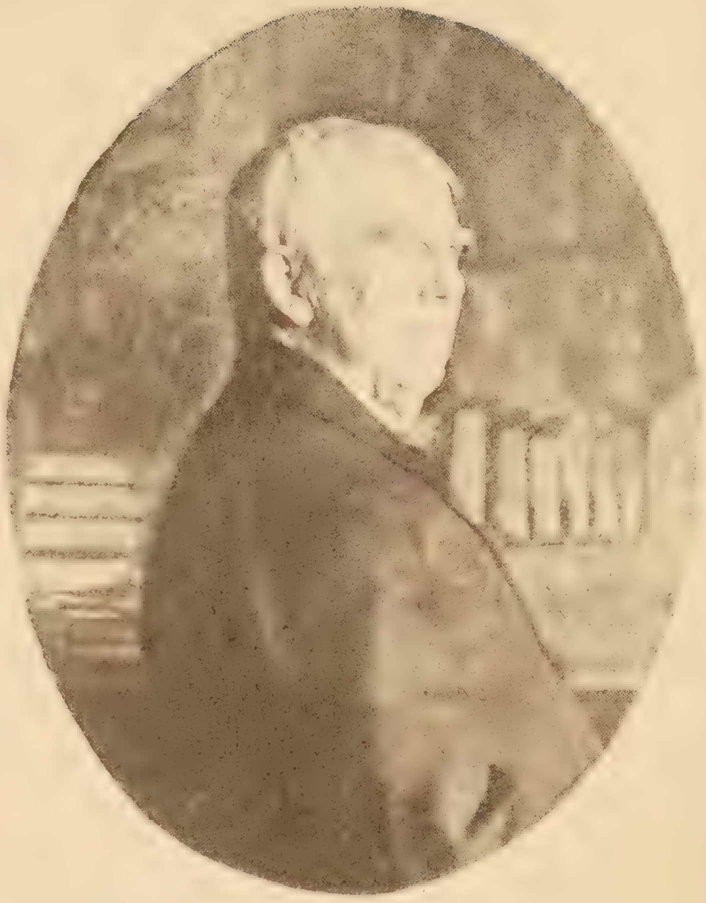
SEMMELWEIS

ROKITANSKY

SKODA
From Max Neuburger's Die Wiener Medizinische Schule in Vormärz.



THE YOUTHFUL HOLMES
Photograph by Hawes.



HOLMES AT EIGHTY-FOUR
Houghton, Mifflin & Co.

OLIVER WENDELL HOLMES IN HIS FAVORITE SEAT AT HIS SUMMER HOME
Photograph taken at Beverly, Massachusetts, by Arthur Dexter, about two weeks before Holmes passed away and first published by Donald Grant Mitchell (Ik Marvel) in his American Lands and Letters, Charles Scribner's Sons.

melweis did not really escape Vienna: all over Hungary's capital the superfluous men known as state-agents eavesdropped and peeped; spies—nasty, sneaky, crawling, slimy creatures, forever pilloried by the grim pen of Maxim Gorky.

The Hungarian Academy of Sciences was closed by pleasure of the law, and the Medical Society of Pest could not meet unless a policeman was present. Semmelweis sighed—what else was there to do? He claimed he did not know how to write, so he could not find solace in the ink-bottle. But he seemed to experiment on the value of doing nothing. He who had been indefatigable became the apostle of apathy, the lord of laziness, a very prince of procrastination.

But such a state of affairs could not last long: Professor Klein did not send Semmelweis money to live upon. Semmelweis had his choice: either make an honest living as a respectable member of organized society, or join a roving gypsy-band and pitch a tent and swing a kettle on any hillside—in which occupation he would have been as comfortable as a frog in acetic acid.

When Rogers saw Lord Brougham ride off one morning, he remarked, "There go Solon, Lycurgus, Demosthenes, Archimedes, Sir Isaac Newton, Lord Chesterfield, and a great many more all in one post-chaise." A similar compliment could not be paid to Semmelweis. He was not a versatile man. He knew his branch of medicine, and nothing more. In fact, he was a man of one idea—but it was a great idea.

Semmelweis now petitioned to be appointed director of the Obstetric Division of the St. Rochus Hospital, a cheerful institution, with windows suggestively overlooking the cemetery. His application was successful, and as soon as he entered he introduced chlorine disinfection. The mortality at the hospital decreased so swiftly and surely that the fame of Dr. Semmelweis spread throughout Budapest. It boomed too his private practice; his office now contained more than one patient at a time.

Thus matters went on for about five years; then Hofrath

Birly, the incumbent of the chair of midwifery in the university, was elegized by his friends, and wreaths were placed upon his coffin. A professorship—fortunately—is not hereditary, and the question arose: Who will succeed old Birly? It is pleasant to record that, in July, 1855, Ignaz Semmelweis was appointed Professor of Theoretical and Practical Midwifery in the University of Pest.

There is no tonic in any Pharmacopeia equal to the elixir of success. Success—it is iron, mother's salve, digitalis, capsicum plaster, catarrh snuff, Godfrey's cordial, Hoffmann's anodyne, Seidlitz powder, brandy and hasheesh all in one. Success purifies the blood, it draws the tip of the chin in, it throws back the shoulders, it straightens the spinal column, it gives color to the cheeks, and brings luster to the eye. The Herr Imperial Royal Professor Semmelweis walked with a jaunty air. He was enthusiastic, and determined to make Budapest the medical Mecca of the world.

When an affectionate bachelor finds himself living on Easy Street, he is apt to speculate in the matrimonial market, especially if a sweet girl like Marie Weidenhofer seems to be fond of him. Ignaz was a bald-headed professor of thirty-eight; Marie was a charming fräulein of eighteen, but they now promised to love each other as long as they lived, and never to quarrel, or cause each other jealousy. How it happened that a shy man like Semmelweis took advantage of the psychological moment is more than we can presume to explain. The best we can do is to quote from Lillian Bell, who exposes all the secrets of sex: "Proposing," claims this lady, "requires a sort of plunge; a burst of courage; a bravery which must be pumped up for the occasion, and that sort of thing your shy man is used to. He cannot even ask a girl to take a walk with him without perspiring under his hatband, so he is accustomed to being afraid and going home without having done it and then longing for it in secret, and finally, goaded to desperation, of making a bolt for it. That is the history of his daily emotional life."

It is fortunate that Semmelweis could now find consolation at home, for the school-year 1857–8 was a frightful one: four per centum of the women in his Lying-in Hospital died from puerperal fever. How Carl Braun and Scanzoni would jeer at him! What was the cause of this dreadful slaughter? When Semmelweis had first assumed charge of the obstetric clinic, he found that the women lay "upon filthy sheets which actually stank of decomposed blood and lochia." Enraged at the circumstance, he pulled the unclean linen from the beds, gathered it into a pile, and rushed to von Tandler, the official in charge. "Smell!" shouted Semmelweis, shoving the foul bundle under his nose. After this practical appeal to the olfactory organ of the Stadtthaltereirath, the laundry contractor was requested to wash the soiled linen before returning it. So the Lying-in Hospital now had clean sheets, chlorine disinfection of course was employed, and yet here was a mortality of 4 per cent. What evil agency was at work, destroying lives with an invisible hand? Semmelweis did not sleep till he discovered the cause: a careless nurse. Either some students had bribed her to disobey the professor, or she herself had no interest in his hobby, because she made it a rule never to go to the trouble of changing sheets, even in the bed in which a patient died from puerperal fever. An expensive idiosyncrasy: it cost 18 out of 449 lying-in women their lives. Semmelweis discharged the culprit whose treachery had brought about the four per centum mortality. A nurse trained in his own prophylaxis—it was enough to make a man go mad.

Semmelweis indeed had reason to be unhappy. His Doctrine made little headway. He could not lift the boulder of prejudice that lay in the path of medical progress.

Primrose and Riolan attacked Harvey's discovery, but denial of the circulation of the blood never injured anyone's health. Many did not accept Newton's law of gravitation, but this stupidity was not followed by symptoms of pyemia. Ohm was considered unbalanced, but failure to comprehend the unit of electrical resistance did not result in phlebitis.

Galvani was ridiculed as the frog's dancing-master, but inability to appreciate the value of galvanism never caused lymphangitis. Cuvier vanquished Lamarck, scoffed at the idea of fossil man, and pitched the bones out of the window in a rage. Scientific progress was thus hindered, and the doctrine of Evolution delayed for a generation, but no man died from metastases because he failed to greet the monkeys in the zoölogical garden as his long-lost cousins.

But to hold erroneous views on the etiology of puerperal fever meant that thousands of wrongly-trained practitioners and midwives went yearly forth to spread disease and death; it meant that countless hosts of mothers were wantonly massacred in state-supported murder-dens. "To be laid on the confinement bed," said Fritsch, "was the same as to be delivered to the hangman."

As late as 1860–3, Achilles Rose was a student at the University of Jena, and he records that during that period no lying-in woman left the institution alive. "All died," he writes, "from puerperal fever. Disinfection of the hands, insisted upon by Semmelweis, had not received any consideration, even by such an eminent man as Professor Schultze."

But an intellectual giant—beside whom the eminent Prof. Schultze was insignificant—saw no good in Semmelweis. To claim that Virchow is one of the greatest sons of Hippocrates is unnecessary, because it is undisputed. But there was this difference between the Greek and the German: the latter had limitations. His opposition to Semmelweis was by no means his only sin. Carl Ludwig Schleich's discovery of infiltration anæsthesia was swamped by Virchovian sarcasm. Certainly his attitude on the germ question was not to his credit: "I must ask my friend Klebs to pardon me," he said, "if, notwithstanding the late advances made by the doctrine of infectious fungi, I still persist in my reserve as far as to admit only the fungus which is really proved, while I deny all other fungi so long as they are not actually brought before me." When Haeckel desired that Evolution be included in the curricula of the public schools, Virchow took the contrary view—with vehemence. Virchow claimed there was an essential difference between the skull of primitive man and the ape, arguing that no human being had an orbital stricture as pronounced as is found in the Pithecanthropus. The words were hardly out of his mouth when Nehring found a skull of a Brazilian Indian in the Sambaquis of Santos, in which the stricture was deeper than in many of the apes. And then how puerile was Virchow's warning, "Darwinism leads to Socialism!" Since when has it been the duty of the scientist to worry what anything leads to? It is the function of the scientist to find the fact and accept the conclusion, be it saccharin or gall. It may be unpleasant to contemplate that man is a freak of nature, and will ultimately disappear from the earth, but if such be the facts, then scientists must announce them, or cease to lay claim to the title of truth-seekers. Virchow's admonition deserves to be placed by the side of Agassiz's complaint, "Darwinism seeks to dethrone God, and replace him by a blind force called the law of evolution." Virchow's attitude towards Darwinism was so unfair, that the ever-gentle Darwin, who could rarely be provoked to retort, wrote to Haeckel, "Virchow's conduct is shameful, and I trust he will one day feel the shame of it." But Virchow evidently did not repent, for as late as 1894, at the Anthropological Congress in Vienna, he said, "a man might just as well have descended from a sheep or an elephant as from an ape." Virchow, in later years, liked to speak of "the point where science makes its compromise with the church." Shall we say of Virchow as Nietzsche said of Wagner: "He succumbs at the cross of Jesus Christ"? But Father Time has amusing little tricks of his own: yesterday, Rudolph Virchow, the scientific founder of cellular pathology, rejected Darwinism, and to-day the Jesuits themselves are accepting it!

Semmelweis now saw that he must do what he had long declared he could not do—write a book. "I cannot write," he told his devoted friend Markusovsky, who continually urged him. "I have a congenital aversion to all that is called writing." But the groans of the lying-in women dying of childbed fever caused by the pupils that Carl Braun and Scanzoni sent out into the world, thrust the pen into unwilling fingers.

One day in 1860 Dr. Hirschler was strolling along the streets, when he was seized by an excited individual who insisted that he come to his home at once. Dr. Hirschler complied with the urgent demand, and no sooner did the friends seat themselves than the host opened a drawer, pulled out a huge manuscript, and began: "My Doctrine is not established in order that the book expounding it may molder in the dust of a library: my Doctrine has a mission, and that is to bring blessings into practical social life. My Doctrine is produced in order that it may be disseminated by teachers of midwifery, until all who practice medicine, down to the last village doctor and the last village midwife, may act according to its principles; my Doctrine is produced in order to banish the terror from the lying-in hospitals, to preserve the wife to the husband, the mother to the child."

So Hirschler learnt that Semmelweis had at last completed his book: *The Etiology, Nature, and Prophylaxis of Puerperal Fever.* Semmelweis had underrated his literary ability: he *could* write. As far as its scientific value is concerned, no praise can be too high: page after page could stand, without revision, in the most modern treatise on the topic. Arnold Lea's *Puerperal Infection* just off the press and fresh from the bindery, does not antiquate Semmelweis's work—it supplements it.

But the book did not sell. And the lecture-rooms still reechoed with ancient nonsense about epidemic puerperal fever, while the examining finger and the operating hand still committed murder. Semmelweis called his discovery "the puerperal sun which arose in Vienna in 1847," but its rays were dimmed by Breisky mist and obscured by Carl Braun clouds.

Semmelweis was a disappointed man. He became bitter, irritable, old. Sometimes when he smiled to his wife, she saw how weary he was. But Semmelweis had learnt the lure of writing, and the pen was now his constant companion. And this instrument which he had hitherto feared became in his hands a burning lash and a flaming sword.

In Disraeli's *Quarrels of Authors,* there is no controversy more fierce than Semmelweis's *Open Letters to Professors of Midwifery.* In these letters we do not recognize the gentle man of earlier days; we see instead an exasperated antagonist, desperate, emotional, fanatical, furious. "My doctrine," he writes to Scanzoni, "is based on my experience. Your teaching, Herr Hofrath, is based on the dead bodies of lying-in women slaughtered through ignorance; and I have formed the unshakable resolution to put an end to this murderous work as far as lies in my power. If, Herr Hofrath, without controverting my teachings, or giving reasons for assuming them erroneous, you continue to teach your students the doctrine of epidemic puerperal fever, I denounce you before God and the world as a murderer, and the History of Puerperal Fever will not do you an injustice when, for the service of having been the first to oppose my life-saving *Lehre,* it perpetuates your name as a medical Nero."

These terrible *Open Letters* only amused the professors. "Have you been scorched by the puerperal sun?" asked one. "The Hungarian crank is simply crazy," said another.

No longer able to control himself, Semmelweis stopped laborers and business-men on the streets, and tried to make them listen to his Doctrine. They tapped their foreheads significantly, and passed on. It was not these people, however, that caused Fritsch's epigram: "There is a dark chapter in the history of midwifery, and it is headed—Semmelweis."

During a meal, Semmelweis behaved strangely, and when Marie looked into his eyes she saw that reason had left him. She ran to his friend, the editor of *Orvosi Hetilap.* "Nonsense," said the good Markusovsky, "nonsense, I assure you. He is excited; can you blame him? He will be all right to-morrow. I will come to see him. There is no cause for worry." But Ludwig Markusovsky knew he lied, for he himself had sickening suspicions.

A few days later it was no longer possible to conceal the circumstances, and it was decided to remove Semmelweis to an insane asylum in Vienna, where he would be under the care of Dr. Riedel, the eminent alienist. On the last day in July—his birth-month—in 1865, when he was forty-seven years of age, the journey was begun. Some friends and relatives, his wife and infant child, accompanied the invalid. By means of a stratagem, Ferdinand Hebra induced him to enter the asylum. Fifteen years ago, Semmelweis had left Vienna—angry; now he was brought back—mad. Perhaps he had often dreamed of returning, but hardly like this.

Within a day or two it was discovered that Semmelweis had a wound in his finger, the result of his last gynecological operation. Gangrene set in, cellulitis developed along the arm, metastases followed, and soon Semmelweis lay in the deadhouse, ready for a post-mortem examination. So Semmelweis fell a victim to pyemia, which he had discovered to be identical with puerperal fever, and which he sought to exterminate by antisepsis.

Thee nor carketh care nor slander,
Nothing but the small cold worm
Fretteth thine enshrouded form—
    Let them rave.
Light and shadow ever wander
O'er the green that folds thy grave—
    Let them rave.

But they rave no more. His grave had hardly closed when Pasteur and Lister began to make a microscopic bacterium reveal its deadly secret, and then all the world knew that Semmelweis had been right since 1847, and a magnificent monument was raised to his memory. The great obstetrician is seen in full, holding his book under his arm; on the step of the pedestal sits a woman, with her infant in her arms, gazing reverently at her benefactor. "I stood to-day with

MONUMENT TO SEMMELWEIS AT BUDAPEST

uncovered head by the monument of Semmelweis," writes a physician from the International Medical Congress at Budapest; "it is very beautiful, and is kept green and is well taken care of by a special watchman." Ah, if they had been as tender to the man as they are to his statue, his career would have been happier.

Yet it is well that Semmelweis has been thus honored, and though that marble mausoleum at Budapest may crumble in the course of centuries, there is one monument to the beloved physician which shall endure as long as the human female bears children: Motherhood is safer because Semmelweis lived and worked.

(1821-1910)

ELIZABETH BLACKWELL

In this determination a new key-note was sounded. The Blackwells, and especially Elizabeth, were less the associates of Harriot Hunt, and of their own immediate successors, than the spiritual daughters of Mary Wollstonecraft, whose courageous demand for a wider field for her sex had remained hitherto almost alone, like a voice crying in the wilderness. They did not seek wider opportunities in order to study medicine, but they studied medicine in order to secure wider opportunities for all women.

It was by sheer force of intellect, and of the sympathetic imagination born of intellectual perception, that Elizabeth Blackwell divined for women the suitableness of an occupation whose practical details were, to herself, intrinsically distasteful. Among all the pioneer group of women physicians, hers chiefly deserves to be called the Record of an Heroic Life. For with her, the struggle with bitter and brutal prejudices in the world was not sustained by the keen and instinctive enthusiasm for medicine, which has since carried hundreds of women over impossibilities. Rather was the arduousness of the struggle intensified by a passionate sensitiveness of temperament, which, under a cold exterior, rendered her intensely alive to the hardships of the social obloquy and ostracism which she was destined to encounter in such abundance.

MARY PUTNAM JACOBI (1891).

XXVI

ELIZABETH BLACKWELL

The newspapers put birth-notices and obituaries on one page —but nature does the same. The storm uproots the oak, and it falls, but on the spot where the pride of the forest has perished, a blade of grass springs up to tell again the miracle of life. In the year that death reached Napoleon on the rock of St. Helena, and smote earth's mightiest giant, a baby girl was born to Mr. and Mrs. Blackwell at Number One Wilson Street, Bristol, England. She was their third daughter, and they named her Elizabeth. She was a lively little thing, and before she outgrew her bib she dispatched, in partnership with her sisters, a request to papa for permission to play on the roof of this house. But father returned an ultimatum from which there was no appeal:

Annie, Bessie, and Polly,
Your request is mere folly,
The leads are too high
For those who can't fly.
If I let you go there,
I suppose your next prayer
Will be for a hop
To the chimney top!
So I charge you three misses,
Not to show your phizes
On parapet wall,
Or chimney so tall,
But to keep to the earth,
The place of your birth.

The home of the Blackwells was encircled by brooks and violets and Sir Richard Vaughan's peacocks, and every day the young generation romped for hours along the elmy avenues of wooded Bristol. The children were not sent to school;

private governesses and tutors instructed them, and it must have been a valuable education for these teachers to come into contact with such splendid, wholesome children. They were the heirs of comfort and culture, and only vaguely did the troubles of the outside world penetrate their enchanted demesne. In after years Elizabeth retained a dim recollection of having heard something of the Bristol Riots, and of the incendiary fires which had been lit by men driven to desperation.

In 1832 the family prepared to move, and as Elizabeth was eleven, she was old enough to share in the excitement: the family was going to settle in America. The elder Blackwell preferred republican institutions, and intended to introduce the method of refining sugar by the vacuum pan process. When they left England, the cholera was sweeping across the country, and on the voyage several steerage passengers died from the disease, but the Blackwell family remained in good health, and the youngsters enjoyed the decks of the Cosmo as much as the fields of their native town.

They found New York also sick with the international malady—cholera is not a local affair. Manhattan Island looked as if it could be bought again for twenty-four dollars, but its value increased when Samuel Blackwell with his wife and descendants settled there. England has given to America no better gift than the Blackwells. From the first they identified themselves with unpopular and righteous causes. It did not take them long to become ardent abolitionists: William Lloyd Garrison became a frequent guest, and on one occasion the Reverend Samuel H. Cox, who had incautiously asserted that the Lord Jesus belonged to a race with darker skins than ours, and was thus about to be lynched because he "called Jesus Christ a nigger," sought shelter and safety at their country home on Long Island.

When Elizabeth was seventeen, the family determined to go westward. Mr. Blackwell believed that by cultivating beet-sugar in that section he would strike a blow at slave-grown cane-sugar. With their capacity for enjoyment, they were delighted with the rivers and mountains they crossed by canal and stage. Full of anticipation, they sailed down the forest-lined Ohio until they reached the flourishing town of Cincinnati, which had already been put on the medical map by such makers of American medicine as Daniel Drake, John D. Godman, Samuel David Gross, John Eberle, Reuben Dimond Mussey, Willard Parker, and Marmaduke Burr Wright. But in those days Elizabeth Blackwell had no interest in medicine.

For a few months life was a song, but during the summer a bilious fever ended the career of the beloved father of the group. We may ask with the learned Robley Dunglison, "What do you mean, sir, by biliousness?" and we may not know, but we know that Samuel Blackwell was dead. It was a staggering calamity, and aside from the sorrow which was like a thousand knife-thrusts in the heart, the once-happy family found themselves unprovided for in a strange land. Fate has no favorites —those upon whom she smiles to-day, she will smite tomorrow.

As soon as they were able, the three elder sisters established a boarding school for young ladies, and the broken family circle kept together in Cincinnati until 1844, when Elizabeth was invited to take charge of a district school that was being organized in Henderson, Kentucky—where Robert Owen's scientific son, Dr. David Dale Owen, exhumed a practically complete megalonyx.

Like many girls, Elizabeth was an interesting letter-writer, and as this was her first separation from home, she wrote long descriptions of everything that happened in that muddy little Kentucky village. Her advent into Henderson was like a fresh breeze blowing over a stagnant pool. The men were slow, the women hysterical, and everyone chewed tobacco and abused the negroes. But along the river bank was a beautiful spot known as Lovers' Grove, where the sexes strolled and carved each other's initials on the "unfortunate locust trees." Elizabeth was often invited there, for the beaux admired her white teeth and other virtues. She accepted once or twice, but soon got dreadfully tired of such sentimentality, and while her swain was busily engaged in engraving an E on one side of the tree, she started off alone on what she called "a good brisk walk," and Lovers' Grove knew her footsteps no more. At the end of the first term she resigned her position, for although her associates treated her with respect and kindness, nothing could induce her to remain in a community where human beings, on account of the color of their skin, were held in the house of bondage.

On her return to Cincinnati, a friend who suffered severely from a gynecological complaint, said to Elizabeth, "You are fond of study—why not study medicine? If I could have been treated by a lady doctor, my worst ordeals would have been spared me." Miss Blackwell flouted the idea as utterly preposterous. Her favorite studies were history, and—we regret to say—metaphysics. She informed her friend that she remembered when her teacher in physiology, in order to arouse the interest of his students in the wonderful structure of the eye, had exhibited a bullock's eye resting on its cushion of rather bloody fat—and she felt simply horrified. But that night, as she lay in bed, Elizabeth Blackwell seemed to hear the voice of suffering womanhood: "If I could have been treated by a woman physician, my worst trials would have been spared me."

As the idea gradually took shape it no longer seemed strange, and there was another circumstance which impelled her to seek the Hippocratic shrine; with charming naïveté she confesses that she was extremely susceptible to "the disturbing influence exercised by the other sex." She says that ever since she was seven she was perpetually falling in love, and one acute attack, instead of conferring immunity, was speedily followed by another. But the thought of marrying and leading the existence of a housewife, was repellent to her. Those were the times that stirred women's souls: Lucy Stone and Lucretia Mott and Belva Lockwood and Susan Anthony and Elizabeth Cady Stanton were striking the shackles from their sex and leading them into a new world—and the Blackwells marched in the vanguard. "I felt," wrote Elizabeth Blackwell during her next attack, "more determined than ever to become a physician, and thus place a strong barrier between me and all ordinary marriage. I must have something to engross my thoughts, some object in life which will fill this volume and prevent this sad wearing away of the heart."

In 1845 she received an offer to teach music at the school and parsonage of the Reverend John Dickson, of Asheville, North Carolina. We can now go around the world in the time that it then took to travel from Cincinnati to Asheville: many rivers had to be forded, and three ranges of railwayless mountains to be crossed. But Elizabeth decided to go for two reasons: in the first place she needed the money, and secondly, the Reverend John Dickson had previously been a physician, and in her leisure hours she could study his medical books.

A portion of one of the long letters which she wrote from her new surroundings deserves to be quoted, as it exhibits her vivacity, gives us a description of her first medical case, and proves how deeply interested was North Carolina in the welfare of its colored population:

> DEAR MOTHER—I received your welcome letter last night while engaged in your favorite Saturday evening's employment—singing hymns. A strange minister who was to preach next day had just arrived, and I, seated at the piano, surrounded by the girls, was supplying him with sacred entertainment, when Howard Dickson laid your letter beside me. I smiled, and gave an involuntary quaver in the "Come, Holy Spi—," which made the girls giggle; but seeing the four eyes of the two ministers bent astonishedly upon us, I pulled a long face, the girls straightened theirs, and we continued—"rit, heavenly Dove."
>
> I soon ran off with a candle and my letter, and read with eagerness all the profane parts, and most of the religious, as it is a first letter. I am very glad that you derive so much peaceful satisfaction from Upham. I know it has a soothing influence, for whenever I had to go into your room of an afternoon I found

> you asleep on the bed with the book in your hand; but I find no lack of such books here—Jonathan Edwards on the Affections, which I have lately read, has the same peaceful tendency.
>
> I have just performed my first professional cure, and am already dubbed Dr. Blackwell by the household. I mesmerised away a severe headache that afflicted Miss O'Heara, a kind-hearted, child-like, black-haired little old maid, the favorite of the family and especial pet of the children. She had just recovered from a very severe attack of illness, and great suffering in the mouth from calomel, which made her declare that no physician ought to receive his diploma till he has been salivated, that he may know the torture he is inflicting on his patients. I went into her room last night, and found her suffering from an intense throbbing headache. I offered to relieve her, half doubting my own powers, never having attempted anything of the kind; but in a quarter or half an hour she was entirely relieved, and declared some good angel had sent me to her aid.
>
> . . . When I first came here I determined to teach all the slaves I could to read and write, and elevate them in every way in my power, as the only way I could reconcile it to my conscience to live amongst them; but to my consternation I found that the laws forbade it, and that Dr. Dickson was not willing to evade them. . . . I longed to jump up, and taking the chains from those injured, unmanned men, fasten them on their tyrants till they learned in dismal wretchedness the bitterness of that bondage they inflict on their brethren.

In 1846 the school at Asheville was disbanded, and Miss Blackwell journeyed across the Alleghanies to the rice-fields of South Carolina. At Charleston she was welcomed by Dr. Samuel Henry Dickson, who obtained for her a teacher's position in the fashionable boarding-school of Mrs. Du Prè. All her spare time was spent in pursuing the medical studies which Dickson directed. At that time he was one of Charleston's leading physicians, and had been the teacher of James Marion Sims, who thus describes him:

> The Charleston Medical School was opened a very few days after my arrival. Dr. Samuel Henry Dickson was the Professor

of Theory and Practice of Medicine. I well remember the introductory lecture; it was a brilliant effort, and I never heard such eloquence from a teacher's desk. He was a small man, very handsome, with a sweet, musical voice; a man of great literary acquirements, a fluent speaker, logical in his reasoning, convincing in his argument, and most captivating in his manner. But as a practical teacher I do not think that I ever learned much from him. The purity of his diction, and the eloquence of his discourse, and the beauty of his teaching captivated the ear, so that I was carried away entirely from the substance of what he attempted to instill into my mind.

Professor Dickson in later life was invited to become a member of the faculty of the Jefferson Medical College, of Philadelphia, and was thus included in that medical Baedeker, Samuel D. Gross's Autobiography. In those days, all medical roads led to Philadelphia, and here came Elizabeth Blackwell in the summer of 1847. There were four medical colleges in Philadelphia, and she determined to enter one of them. Philadelphia was full of famous professors; seven was considered the proper number for a faculty, and in the University of Pennsylvania were Nathaniel Chapman, Robert Hare, William Gibson, William E. Horner, Samuel Jackson, George B. Wood, and Hugh L. Hodge, while at the Jefferson Medical College the chairs were occupied by Robley Dunglison, Joseph Pancoast, Charles D. Meigs, Franklin Bache, Robert M. Huston, John K. Mitchell, and Thomas D. Mutter.

She called upon the venerable Dr. Jackson, whose long, white hair was one of the landmarks of the city. When Miss Blackwell informed him that she wished to study medicine, he laughed and asked her why. Then she grew eloquent with reasons, and he became interested. He said he would do what he could for her, and asked her to come the following Monday for an answer. A Sabbath never seemed so long, but the next day, eager and hopeful, she presented herself at Jackson's office—and learned that the authorities were opposed to her entrance.

Dr. Horner advised her to try the Filbert Street and Franklin schools. She applied, but was not accepted. Then a professor at the Jefferson Medical College informed her that it would be impossible to study in Philadelphia, but thought she might enter one of the New England schools. Dr. Pankhurst said he approved of her plan personally, but it was out of the question; however, if she would disguise herself as a man, he would permit her to attend the classes.

She interviewed Dr. Darrach, who could have given the Sphinx lessons in the delicate art of non-committalness. She spoke to him for a considerable time, and he sat for several minutes without a reply.

"Can you give me any encouragement?" she asked at last.

"Madam," he said, "the subject is a novel one; I have nothing to say either for or against it; you have awakened trains of thought upon which my mind is taking action, but I cannot express my opinion to you either one way or another."

"Your opinion, I fear, is unfavorable."

"I did not say so. I beg you, madam, distinctly to understand that I express no opinion one way or another; the way in which my mind acts in this matter I do not feel at liberty to unfold."

"Shall I call on the other professors of your college?"

"I cannot take the responsibility of advising you to pursue such a course."

"Can you not grant me admittance to your lectures, as you do not feel unfavorable to my scheme?"

"I have said no such thing; whether favorable or unfavorable, I have not expressed any opinion; and I beg leave to state clearly that the operation of my mind in regard to this matter I do not feel at liberty to unfold."

By this time her Quaker friend, Dr. Warrington, was thoroughly discouraged. "Elizabeth," he said, "it is of no use trying. Thee cannot gain admission to these schools. Thee must go to Paris and don masculine attire to gain the necessary knowledge."

But Elizabeth Blackwell was waging a moral crusade; her task was to open the doors of the medical profession not for herself alone, but for her sex; disguises and evasions would not answer. She must fight the battle in the light of day.

She appealed to the schools of New York City, but like an unsuccessful manuscript, she was everywhere rejected with thanks. Blessed are the fanatics, for they never fail. She obtained a complete list of the smaller schools of the northern states, and wrote to a dozen of these country colleges—among them being the Geneva Medical College.

"Geneva," said John Morley, "is no grain of sand; it is a grain of musk that perfumes all Europe." But Rousseau's biographer did not refer to Geneva in New York State. For the American Geneva was a town of turbulence, ruled by a lawless crew, over one hundred strong. They answered roll-call at the Geneva Medical College, but mischief was their desire and their delight. Rough and riotous daredevils, they interrupted every lecture with their noisy blustering—except when Doctor Webster, the merry professor of anatomy, was relating a story that was unfit for publication. These rowdy-dowdy students were a source of terror to Geneva's inhabitants, who threatened, on more than one occasion, to have the college indicted as a nuisance. But the faculty itself feared these young men—they were the sort who could demand their diplomas and other rights at the point of a horsewhip or a revolver. Yet there was good material among these boys, and some of the matriculants of the Geneva Medical College became eminent physicians—Moses Gunn and Corydon L. Ford and Stephen Smith.

On the twentieth of October, 1847, Charles A. Lee, the dean of the medical department, entered the lecture-room, and begged the class for their attention; waving a letter, he explained that it contained the strangest request that ever was made to any faculty. The curiosity of the students was aroused, and they listened while Doctor Lee read an application to allow a woman to enter the college as a student. "Gentlemen," concluded Doctor Lee, "for this petition there is no precedent;

never has a lady been admitted as a medical student; the decision of this matter rests with you." A mighty shout greeted this announcement, and as the professor escaped from the lusty lungs and the stamping feet, he could not help thinking that any woman who was imprudent enough to venture into this trousered domain, would soon repent of her temerity.

That evening the class called a meeting to discuss the situation; a fellow named Stratton acted as chairman, and he certainly had to pound the gavel; speeches in the wildest hyperbole, entangled with laughter, cheers and applause, formed the program until it was decided to take a vote. "All those in favor of admitting the lady," said Stratton, "will signify by saying, Yea." An ear-splitting "Yea!" shook the room. "Contrary, No," continued the chairman. For a moment all was still, then the silence was broken by a faint and single "No." Immediately the class laid violent hands on Geneva's solitary opponent of co-education, and he shouted a "Yea," which made the decision, like Washington's election, unanimous. The following resolutions were accordingly dispatched to the applicant:

> *Resolved,* That one of the radical principles of a Republican Government is the universal education of both sexes; that to every branch of scientific education the door should be open equally to all; that the application of Elizabeth Blackwell to become a member of our class meets our entire approbation; and in extending our unanimous invitation we pledge ourselves that no conduct of ours shall cause her to regret her attendance at this institution.

More than two weeks passed, and as nothing further was heard from the applicant, the rumor spread that the whole thing was the hoax of a rival institution—which was easy to believe in the days when medical colleges sprang up in the night and disappeared as suddenly. But on the seventh of November the professor entered the lecture-room, followed by a young lady. She was pretty and small—and very serious. The students turned a surprised and curious eye upon her, and then hurriedly took their seats in silence. There was something about her that sobered that class into decency. Those students who had voted for her because they had visions of flirtations with a petticoat, now realized their mistake. They might admire her from afar, but knew they would be permitted no intimacy. The professor began his lecture, and there were no interruptions, because only Elizabeth Blackwell was listening to him. The others were glancing furtively at the new arrival, and wondering where she came from and who she was.

She was well-received by the dean, Charles Alfred Lee. He was a peripatetic professor, teaching in various colleges throughout his career, and had the felicity to be quoted by Holmes in his immortal essay on the *Contagiousness of Puerperal Fever*. Dr. Lee edited, with extensive notes and editions, *Guy's Principles of Forensic Medicine,* and Copland's *Dictionary of Practical Medicine,* in three colossal volumes. He wrote *Physiology for the Use of Elementary Schools* and a *Manual of Geology*. He was one of the founders of the Buffalo Medical College, which has survived, and of the New York Medical College, which hasn't. He was one of the founders and editors of the New York Journal of Medicine. Gross, who met Lee for the first time in July, 1832, during the terrible visitation of Asiatic cholera in the city of New York, says he was a physician of not a little note in his day, and describes him as "a tall, handsome man, with a large head and a keen brown eye, a ready talker and writer." His name lives in Charles Alfred Lee Reed, a former president of the American Medical Association, who at present is attempting to gain immortality by proving that epilepsy is caused by a bacillus.

But the professor whom Miss Blackwell mentioned most frequently in her letters was James Webster, who edited the Medical Recorder until it was incorporated into the American Journal of the Medical Sciences. Dr. Webster was trained by the ill-fated but gifted John D. Godman, and was fresh from the directorship of the Philadelphia School of Anatomy, which was an American edition of the Great Windmill Street

School that William Hunter established in London. The Philadelphia School of Anatomy had no charter and granted no degrees, but for half a century it gave this country her chief anatomists. The history of the Philadelphia School of Anatomy is practically the history of early anatomy in America—and W. W. Keen has written it.

Webster was a fat, fussy, cheerful and likable little man; he grasped Miss Blackwell's hand so cordially and encouraged her to such an extent that in the diary it is written:

> November 9.—My first happy day; I feel really encouraged. The little fat Professor of Anatomy is a capital fellow; certainly I shall love fat men more than lean ones henceforth. He gave just the go-head directing impulse needful; he will afford me every advantage, and says I shall graduate with éclat.

But then came trouble; Dr. Webster was reaching that branch of anatomy which he embellished with piquant remarks that were for men only. He accordingly requested Miss Blackwell to absent herself from these lectures, offering to go over the subject with her in private. This made her sad; she wrote him a note saying that she was there as a student with an earnest purpose, and as a student simply she should be regarded; she said that the study of anatomy was a most serious one, exciting profound reverence—and James Webster thought he was listening again to John D. Godman. He was completely disarmed, and read her note to the class, while Elizabeth, who was waiting in the ante-room, listened with a full heart to the applause of the students. The professor opened the door for her, she entered amid an ovation, and throughout that term Webster lectured on anatomy without anecdotes.

Personality is a mysterious thing—and Elizabeth Blackwell had it. She tamed the Geneva Medical College. She has repeatedly testified that the behavior of the class during the two years that she was there was admirable. Her place in the vari-

Elizabeth Blackwell M.D.
With kindest regards.

ELIZABETH BLACKWELL

EMILY BLACKWELL

ous lecture-rooms was always kept for her, and during dissecting demonstrations, when the students crowded around, standing on stools and leaning against each other, they kept respectfully from her, and when they accidentally touched her head or shoulder, they drew back instantly.

The outsiders were not so easily won. A doctor's wife refused to speak to her; the women of the town gathered in groups when she passed—they decided she was either unbalanced or immoral. The children, who heard things, stared at her.

But Elizabeth Blackwell felt she was a marked person: through her the race would advance. Every act and word of hers must be beyond criticism. She hurried from her class to her room—every pioneer renounces the pleasures of the world. Late in the night, when all Geneva lay in its blanket, one light was still burning—Elizabeth Blackwell sat over her books; or a figure moved silently in the dissecting-room: Elizabeth Blackwell still plied her scalpel—so that thousands of women might hold it after her.

On the twenty-third of January, 1849, Miss Blackwell received what no woman had ever received before—a diploma which made her an M.D. One of her younger brothers was present at the graduating exercises, and wrote home a grandiloquous letter, which read in part as follows:

> Beloved Relations—The important crisis is past, the great occasion over, the object of so much and so justifiable anticipation has been attained, and proud as I always feel of the Blackwells, my familism never seemed to me so reasonable and so perfectly a matter of course as it did this morning, when, having escorted E. into the crowded church and taken my seat beside her, we learned from the music that the graduating class, headed by the dean, trustees, faculty, etc., were marching in solemn conclave into the aisle . . .
>
> On the morning of the Commencement little Dr. Webster was in his glory; he is a warm supporter of Elizabeth and likes a fuss, and nothing could exceed his delight when he found that

the whole country round was sending in large numbers of people, and that all the ladies of Geneva were turning out en masse to see a lady receive a medical diploma. . . .

After a short address by Dr. Hale, the President, the diplomas were conferred—four being called up at a time—and, ascending the steps to the platform, the President addressed them in a Latin formula, taking off his hat, but remaining seated, and so handed them their diplomas, which they received with a bow and retired. Elizabeth was left to the last and called up alone. The President taking off his hat, rose, and addressing her in the same formula, substituting Domina for Domine, presented her the diploma, whereupon our Sis, who had walked up and stood before him with much dignity, bowed and half turned to retire, but suddenly turning back replied: "Sir, I thank you; by the help of the Most High it shall be the effort of my life to shed honor upon your diploma"; whereupon she bowed and the President bowed, the audience gave manifestations of applause, little Dr. Webster rubbed his hands, the learned curators and faculty nodded grave approbation at each other upon the platform and our Sis, descending the steps, took her seat with her fellow-physicians in front.

Now up walks into the pulpit Professor Lee, with a large manuscript and a solemn air, and commences his address to the graduates. It was on the whole good; he gave it pretty strong to Homeopathists, Hydropathists, Mesmerists, Thompsonians, etc., and gave the ladies of the audience quite a lecture for their encouragement and circulation of quack medicines, informing them that they had better study a little the principles of medicine before attempting to practice what they were so profoundly ignorant about.

At the close he alluded to the novel proceeding which they had taken, and the censure or imitation which it would necessarily create. He justified the proceeding, and passed a most gratifying and enthusiastic encomium on the result of the experiment in the case of Eliz. He pronounced her the leader of her class . . . and by her ladylike and dignified deportment had proved that the strongest intellect and nerve and the most untiring perseverance were compatible with the softest attributes of feminine delicacy and grace.

The novel event attracted much attention, and both the general and the medical press wrote columns about the fair M.D. Punch read about her in the Medical Times, and sent his compliments in these verses:

Not always is the warrior male,
  Nor masculine the sailor;
We all know Zaragossa's tale,
  We've all heard "Billy Taylor;"
But far a nobler heroine, she
  Who won the palm of knowledge,
And took a Medical Degree,
  By study at her College.

They talk about the gentler sex
  Mankind in sickness tending,
And o'er the patient's couch their necks
  Solicitously bending;
But what avails solicitude
  In fever or in phthisic,
If lovely woman's not imbued
  With one idea of physic?

Young ladies all, of every clime,
  Especially of Britain,
Who wholly occupy your time
  In novels or in knitting,
Whose highest skill is but to play,
  Sing, dance, or French to clack well,
Reflect on the example, pray,
  Of excellent Miss Blackwell!

Think, if you had a brother ill,
  A husband, or a lover,
And could prescribe the draught or pill
  Whereby he might recover;
How much more useful this would be,
  Oh, sister, wife, or daughter!
Than merely handing him beef-tea,
  Gruel, or toast-and-water.

Ye bachelors about to wed
  In youth's unthinking hey-day,
Who look upon a furnish'd head
  As horrid for a lady,
Who'd call a female doctor "blue,"
  You'd spare your sneers, I rather
Think, my young fellows, if you knew
  What physic costs a father!

How much more blest were married life
  To men of small condition,
If every one could have his wife
  For family physician;
His nursery kept from ailments free,
  By proper regulation,
And for advice his only fee
  A thankful salutation.

For Doctrix Blackwell—that's the way
  To dub in rightful gender—
In her profession, ever may
  Prosperity attend her!
"Punch" a gold-handled parasol
  Suggests for presentation
To one so well deserving all
  Esteem and admiration.

In 1849 no American physician considered his education complete until he saw Louis—recall Osler's essay, the *Influence of Louis on Modern Medicine,* and the words of Oliver Wendell Holmes: "I doubt if I or my fellow-students did full justice either to Andral or to the famous physician of Hôtel Dieu, Chomel. We had addicted ourselves almost too closely to another master, by whom we were ready to swear as against all teachers that ever were or ever would be. This object of our reverence, I might almost say idolatry, was Pierre Charles Alexandre Louis."

So Dr. Blackwell journeyed to Paris and sent her card to the scientist who overthrew Broussaisism by figures and stopped blood-letting by statistics. The following day, a tall, imposing-looking gentleman called upon her, and she saw the man who had helped to make several of her adopted countrymen illustrious in medical annals—Gerhard and Bowditch and the Jacksons and the Shattucks. She spoke to him of her desire for hospital and practical instruction, and Louis strongly advised her to enter La Maternité.

Thus began another chapter in Elizabeth Blackwell's life. Dr. Blackwell was permitted no privileges because of her medical degree; her status was that of the other pupils, who as a rule were ignorant girls from the provinces, studying to be midwives. But Miss Blackwell found these *élèves* charming and lovable—because she herself possessed these qualities. Her letters during this period are veritable essays in length and language, and her mother must have felt blessed to have a daughter who was equally dutiful and gifted. Some of her pen-pictures are unforgettable. Here, for instance, is an exquisite cameo in words:

> We have one *élève* who goes by the name of "La Normande;" she is one of my pictures. A fresh, healthy complexion, browned by the sun and the sea air of her beautiful home, regular features, a stout, vigorous frame that has never known a touch of sickness, she walks about with a step that feels the ground; in her white quilled cap, and handkerchief pinned over her bosom, she looks with her clear blue eyes right into your face, and has a frank, loyal manner that marks her honest, independent nature. On Sunday she dresses in the short full petticoat, the silk-laced jacket, and the lace-cap, with its towering pyramidal crown and circular ray-like border, that I think I have already described to you. She sometimes visits our *dortoir* and forms the centre of a group, whom she entertains with her constantly overflowing life, sometimes singing, in a deep contralto voice, her peasant hymns to the Virgin—simple, pathetic melodies chanted under the lindens when the day's labors are finished—or dancing vigorously the figures, more gay than graceful, of her country, while she sings some lively air. I admire her vigorous life, I like to see her in the infirmary; she tends the sick with such an honest awkwardness, such a kind heart, and lifts them like babies in her strong arms, that I see the green fields and smell the sweet country air as I watch her.

Elizabeth wrote also to her mother about a handsome interne, M. Blot, who blushed, or looked intently at one of the babies, or passed his fingers through his hair, whenever she asked him a question, so she determined not to disturb his young life in that way. But gradually they grew more sociable and discussed various matters, and on one occasion he told her he had a young friend, named Claude Bernard, who was on the eve of a great discovery.

Dr. Blackwell's Parisian sojourn was gladdened by a letter from Professor Webster and a visit from Professor Lee, but she carried away from La Maternité a sad memento:

On the fourth of November, 1849, she served in the infirmary as usual; she felt something was wrong with her eye, but the thought of what it might be was too awful to contemplate. This was before Credé had made himself a benefactor of mankind by putting a drop of silver nitrate in the eyes of infancy, and there was much gonorrheal ophthalmia in the world. She remembered that while syringing one of the tiny patients afflicted with purulent conjunctivitis, a spray of pus spurted into her own eye. At night it was much swollen, and the next morning the lids were adherent from suppuration. The girls wept and assured her she would soon be well and ran for Doctor Blot. The handsome young man examined the eye carefully, and in his looks she read the diagnosis. She was sent to bed, and every two hours, day and night, he attended to her—but the weapons of ignorance cannot conquer a dreaded disease, and of no avail were the leeches to the temple, the ointments of belladonna, and the diet of broth.

Weeks passed and she lay in bed with both eyes closed, and Doctor Blot admired her braid of long hair, wondering how fingers without eyes could arrange anything so beautifully regular. With two frank eyes looking the world bravely in the face she had entered La Maternité, but she left it bandaged and veiled.

As her health was at low ebb, she journeyed to Freiwaldau, in the hope that the hydrotherapeutic procedures of Priessnitz would restore her. Vincenz Priessnitz she describes as "a middle-sized, elderly man, with sunburnt face marked with the smallpox, with gray hair, light-blue eyes, a pleasant expression of face, and dressed in country-best style. I liked his appearance: 'twas honest and good. He examined me very closely with his little blue eyes all the time I was explaining my wishes. Then, in his abrupt manner, he told me he could make me quite strong in about six weeks, and the cure would do no harm to my eye."

At the time of her visit, Priessnitz had 500 patients under his care. He was born an Austrian serf, but by his use of water and sunshine he became a millionaire, and his daughter married a baron.

An inflammation of the eye drove her from the Bohemian mountainside to Paris, where she consulted Desmarres—who taught Albrecht von Graefe, who taught us all. Dr. Blackwell has testified to the skill of Desmarres; the sight of one eye was permanently gone, but within a few weeks he restored his patient to activity. Six months of her life had been lost, and she was forced to abandon her dream of becoming the first of female surgeons.

With the same battling spirit as of old she arrived in England, and in order to prove that she was no slouch, she fought for admittance to the historic Saint Bartholomew's Hospital—what would Harvey or Percival Pott or Abernethy have said? She achieved her aim, and was cordially welcomed by James Paget himself, now famous for his original descriptions of malignant eczema of the nipple, and of osteitis deformans. Here she enjoyed Paget's lectures on surgical pathology, and the physiological lectures of Senhouse Kirkes, whose treatise on physiology was published in 1848 but is still being edited.

During the summer of 1851, Elizabeth Blackwell returned to America, and after settling in New York, she requested an appointment as one of the physicians to the women's department of a large dispensary. As her application was refused, she decided to form a dispensary of her own, for which purpose she rented a room near Tompkins Square. From this humble beginning arose the New York Infirmary and College—of women, for women, by women.

In 1856 Elizabeth Blackwell received an ally who was cast in the same heroic mold as herself—Emily Blackwell. Emily was five years younger than Elizabeth, and when her time came to study medicine, she naturally turned to her sister's alma mater. The Geneva Medical College had put its hand to the plow of progress, but on seeing the impenetrable jungles of prejudice, it left its work unfinished. The Geneva Medical College replied to Emily that they "were not prepared to consider the case of Elizabeth as precedent," so there began again a weary hunt for a college. Finally good news came: Chicago's oldest school, the Rush Medical College, accepted her. She spent her first year here, but on returning for the second term, found herself debarred. For the State Medical Society had berated the Rush Medical College for admitting a woman, and the gallant gentlemen promised to do penance by casting out Miss Emily Blackwell.

Medical societies have too frequently been boulders in the medical path: we have advanced by stumbling over them or by avoiding them. The Philadelphia County Medical Society, meeting in the city where the Declaration of Independence had been signed, inserted in its constitution the resolution that any member who consulted with a woman physician would be expelled. But darkness was all around. Long afterwards, when the Massachusetts Medical Society, as the result of years of argumentation, admitted women as members, this announcement appeared in that antiquated periodical, the Boston Medical and Surgical Journal: "We regret to be obliged to announce that at a meeting of the councillors held October 15, 1879, it was voted to admit women to the Massachusetts Medical Society." Yet in recent issues of the above-mentioned journal, we have read articles by medical women, and in its advertising pages there are requests for female physicians. Tuberculosis is not the most prevalent disease—it is not so widespread as misoneism.

Emily Blackwell was now compelled to search for an institution which would graduate her, and this she found in the Cleveland Medical College of the Western Reserve University. She supplemented her studies by taking courses under James Rushmore Wood, one of the founders of the Bellevue Medical College of New York, who was more noted as a surgeon than as a Latinist, for while he gained Langenbeck's admiration by removing a lower jaw so skillfully that the remaining periosteum formed another jaw, he once admonished his class, "Gentlemen, as you go out into the world remember the eyes of the vox populi are upon you." Emily's postgraduate work was done at Edinburgh, where she was the pupil and assistant of James Young Simpson, who introduced chloroform into obstetrics on the very day and year that her sister left Philadelphia to enter the Geneva Medical College—which we mention for the sake of those who are fond of coincidences. In 1856 Dr. Emily Blackwell returned from her European studies and associated herself with the New York Infirmary for Women, and for years was dean of its Medical College.

In 1859 Elizabeth was again in England, and it was during this visit that the Medical Council, under the presidency of the famous Benjamin Brodie, no longer able to overlook her various credentials, entered her name in the Medical Register; so ten years after becoming the first woman physician in America she became the first woman physician in England. At this time she lectured on a proposed hospital for the treatment of the diseases of women, and her auditors were much moved. "I well remember," said Dr. Blackwell, "the tears rolling down the benevolent face of Miss Anna Goldsmid, who sat immediately in front of me. But the most important listener was the bright, intelligent young lady whose interest in the study of medicine was then aroused—Miss Elizabeth Garrett—who became the pioneer of the medical movement in England."

But when Elizabeth Garrett was halfway through her studies she discovered that no degree would be granted to her in England; consequently she left her country, and in 1870 was the first woman to receive a diploma from L'École de Médecine of Paris. The following year this school conferred the degree upon an American girl, Mary Putnam, who was the first woman to take the entire course there. Upon returning to New York Dr. Putnam became professor of therapeutics and materia medica in the Woman's Medical College that the Blackwells had founded, and when the New York Post-Graduate School was established, Mary Putnam's reputation was so high that she was appointed professor of pediatrics—in a man's school. At the suggestion of the president of the Medical Society of New York County, she was made a member of that society, and a few months later she married the president, Abraham Jacobi. Mary Putnam was probably the ablest of the American women who have studied medicine; her technical knowledge of the science was more extensive than that possessed by the Blackwells, she was the recipient of various professional honors, such as being appointed visiting physician to St. Mark's Hospital, dispensary physician to Mt. Sinai Hospital, delegate to the State Medical Society, chairman of the section of neurology of the New York Academy of Medicine, and contributed not only to the current medical press, but to such solid works as Pepper's System of Medicine, Keating's Cyclopedia of Diseases of Children, and Wood's Reference Handbook of the Medical Sciences. In *Woman's Work in America,* Mary Putnam Jacobi has told the story of the Blackwells.

In August 1859, Elizabeth Blackwell returned to America, and worked here another decade.

Some foreigners become Americans as soon as the steamer docks at Ellis Island, but others remain strangers though they live here for a generation—it is a matter of temperament. Elizabeth Blackwell was brought to this country in 1832, and as she was not yet acclimatized by 1869, she thought it was time to return to her native land.

So she kissed her Americanized sister good-by, and departed for her mother country. She revisited Bristol, and passed Number One Wilson Street. A desire seized her to enter the home where she was born, and its present occupants welcomed her in. As she stood in the hall looking up the stairs, she herself seemed to disappear, and suddenly she saw a childish face peeping wistfully over the railing, and that moment she remembered what she had forgotten for forty years—she had been sent away from the supper-table for a breach of etiquette, but a jolly minister who was present that evening kept the table in a roar, and the banished and supperless Bessie, with her name in the Black Book, had leaned over the banister to catch some of the laughter.

Dr. Blackwell settled in London as a physician, and within her social circle were included some of the most noteworthy personalities of the time. Florence Nightingale and Lady Byron were among her dearest friends, she knew Herbert Spencer and George Eliot and Dante Gabriel Rossetti, and when Charles Kingsley first met her, he greeted her with the exclamation, "You are one of my heroes."

Most people grow old, but Elizabeth Blackwell grew venerable. In 1895 she published her autobiography under the title, *Pioneer Work in Opening the Medical Profession to Women.* It is a delightful book—due chiefly to her letters; if any more of her correspondence is extant, it should be published.

Throughout her career Elizabeth Blackwell delivered various lectures and wrote some essays which in 1902 were collected and published under the title, *Essays in Medical Sociology.* Every author has written at least one book which should be suppressed, and this is the Blackwellian product which ought to be consigned to oblivion.

The trouble with Elizabeth Blackwell is that she was a Swedenborgian-theosophical-teleological-Christian metaphysician, instead of just an unadulterated scientist. On account of her fallacious belief in the beneficence of nature, she rejected immunology. It is true that she had a personal grievance here, for one of the first children she vaccinated, died from the operation, and doctors hate to lose their first patients; Marion Sims lost his first two babies and became so disgusted with himself that he tore his tin sign from his house, cast it in an abandoned well, and left town. Elizabeth Blackwell did not do anything so dramatic, but she philosophized; she wrote that she was strongly opposed to every form of inoculation of attenuated virus, and that she considered it wrong to introduce any degree of morbid matter into the blood of the human system.

She repeatedly refers to herself as a "Christian physiologist," but we must point out that to be a "Christian physiologist," is almost as absurd as being a "Christian scientist." As a matter of fact, Dr. Blackwell was not any sort of a physiologist. But considering herself a Christian physiologist, she finds it necessary to become highly indignant that any one should attempt, in a Christian nation, to introduce circumcision, which she defines as a heathenish and unnatural practice which originated among licentious nations. "Circumcision," she writes, "is based upon the erroneous principle that boys—half the human race—are so badly fashioned by the Creative Power that they must be reformed by the surgeon; consequently, that every male child must be mutilated by removing the natural covering with which Nature has protected one of the most sensitive portions of the human body. . . . Bad habits in boys and girls cannot be prevented by surgical operations. . . . Parents therefore should be warned that this ugly mutilation of their children involves serious danger, both to their physical and moral health."

Not often do so few words carry so many mis-statements, and the last sentence at least, must be characterized by a harsher epithet. Her views on impotence, continence, masturbation, venereal prophylaxis and illicit intercourse, are on the Reverend Sylvanus Stallian style, and have no place in modern sexology.

To Dr. Blackwell's dismay she discovered that London's climate gave her biliary colic, and as a result she established her residence at Hastings. At the mention of that name, many of us hear the clash of contending armies and see the vanquished Harold and William the Conqueror—but some of us think of Elizabeth Blackwell. She too was a warrior. In her girlhood she unsheathed the sword of justice against intrenched prejudice. The battles that she fought were not easy of victory: to overcome the stupidity of ages requires faith, courage, persistence and foresight. Yet she never retired until her cause had triumphed. No medical college in the City of New York would admit women, so she founded one which was continued until Cornell University opened its medical door to her sex. There was no infirmary where women could obtain clinical instruction, so she established a hospital which to-day is flourishing.

School after school has become co-educational. No longer must the woman knock upon gates bolted with bias. The leading institutions now accept her. She is at Johns Hopkins, not only among the students, but on the faculty. She is welcome at the University of Michigan, and at Tulane. She may enter Leland Stanford, and she is invited to Cornell. The Rush Medical College, no longer in fear of the State Medical Society, bids her come. Even the University of Pennsylvania now admits her, but as Miss Sara Frazer Hillman rather tartly says, "As this Medical School was founded in 1765, it has taken Philadelphia over one hundred and fifty years to make up its mind to this rash step." Only the other day, Columbia announced that hereafter women will be admitted to the College of Physicians and Surgeons; and as we write, the news comes that the girls may go to Yale.

In 1910, Elizabeth was eighty-nine years of age, and Emily was eighty-four; in that year both of the sisters passed away—one in Hastings, England, and the other in Montclair, New Jersey. Hand in hand they had fought the good fight, and though the ocean stretched between, together they went down into the peaceful valley of death.

In these pages we have told the story of one of the pioneers, but it would be a pleasant task to tell of the others: of Sarah Adamson Dolley, the second woman in America to receive a medical diploma, after which she organized the Blackwell Medical Society of Rochester, which still exists; of Marie Zakrzewska, the protégée of Elizabeth Blackwell, who founded the new England Hospital for Women and Children, where Susan Dimick, a graduate of the University of Zürich, began her brilliant and brief career; of Ann Preston, who wrote the ever-memorable reply to the reactionary Philadelphia County Medical Society; of Rachel Bodley, the dean and professor of chemistry at the Woman's Medical College of Pennsylvania; of Mary Thompson, whose hospital is still a factor in the medical life of Chicago; of Sarah Hackett Stevenson, the first woman to be appointed to the staff of the Cook County Hospital of Chicago, who was sent in the centennial year as a delegate from the Illinois State Medical Society to the American Medical Association; of Rebecca Cole, the colored physician, to whose virtues and abilities Elizabeth Blackwell has testified in her Autobiography; of Elizabeth H. Bates, who established the Bates Professorship of Diseases of Women and Children at the University of Michigan; of Mary Putnam Jacobi, who said, "Notwithstanding the orthodoxy of the tradition that represents the first woman as risking even Paradise in the pursuit after knowledge, the world continues to preserve a respectful prejudice, to the effect that the less women have to do with knowledge the better." These pioneers are gone, but the women physicians who live and work to-day, have justified the vision of Elizabeth and Emily Blackwell.

A few months ago, at the New York Infirmary for Women, a tablet by the talented Victor David Brenner was unveiled to Emily, whose connection with the Infirmary was of longer duration than that of the English-loving Elizabeth. Interesting individuals spoke at the exercises, and one of them was over ninety years of age: his name is Stephen Smith, and he was one of the boys of the Geneva Medical College when Elizabeth Blackwell came there as a student. This man has seen history —he has seen ten thousand women follow in the footsteps of America's first doctress.

(1822-1895)

LOUIS PASTEUR

My dear Pasteur, forty years ago, you entered this building as a student. From the very first, your masters foresaw that you would be an honor to it, but no one would have dared to predict the startling services which you were destined to render to science, France and the world.

J. B. DUMAS: *to Pasteur.*

That common basis of all beautiful and true work, that divine fire, that indefinable breath which inspires Science, Literature and Art—we have found it in you, Sir—it is Genius. No one has walked so surely through the circles of elemental nature; your scientific life is like unto a luminous tract in the great night of the Infinitesimally Small, in that last abyss where life is born.

ERNEST RENAN: *to Pasteur.*

For the first time in the history of Science we have the right to cherish the sure and certain hope that, as regards epidemic diseases, medicine will soon be delivered from quackery and placed on a real scientific basis. When that day arrives, Humanity, in my opinion, will know how to recognize that it is to you that will be due the largest share of her gratitude.

JOHN TYNDALL: *to Pasteur.*

XXVII

LOUIS PASTEUR

[Written for the Centenary of his Birth]

General Baron Delort, a peer of France, was the foremost personage of the little town of Arbois. General Baron Delort, ex-aide-de-camp to Louis Philippe, decided to immortalize Arbois by bequeathing to it his memoirs and his uniforms. General Baron Delort, a leader of the Legislative Corps, walked over the Cuisane Bridge holding his head high, for there was a tannery below and he did not appreciate the odor.

Since General Baron Delort never looked down into the tanyard, he did not notice the man and his wife and their three daughters and pale-faced boy. The sensitive boy gave no evidence of unusual gifts—except that he could draw well—but on the whole his childhood was happy. No doubt his most terrifying experience occurred in his ninth year: a mad wolf was running through the countryside, biting animals and human beings, several of whom died from suffocation. Near his father's tannery stood the smithy, and here the boy saw one of the bitten Arboisians seared with a red-hot iron—cauterization was advocated by the Roman physicians of the first century, and the passing centuries had added no wisdom in hydrophobia. The foremost physicians of modern times, from Boerhaave to Hunter, and from Magendie to Virchow, had studied this malady in vain. For about two thousand years the doctor turned over his rabic patients to the blacksmith.

One autumn day, General Baron Delort passed over the Cuisane Bridge, unaware that a revolution had occurred in the tannery below. The father prepared his skins in the pits as usual, the mother toiled in the little kitchen, the girls chatted together—but the boy was gone. He was approaching his sixteenth year, and his parents had sent their only son, with a comrade named Jules Vercel, to study in the French capital.

Was there ever a country lad who did not succumb to Paris, the paradise of pleasure? History records one such example. The tanner's boy from Arbois found no joy in Paris. Melancholy by day and sleepless at night, he presented a picture of adolescent despair. His teachers attempted to amuse him, but no smile played in those set features. He was visibly ill—suffering from homesickness. "If I could only get a whiff of the tannery yard," he confessed to his companion, "I feel I would be cured."

In the meantime, sorrow brooded over that tannery: between Arbois and Paris love-waves crossed and recrossed. Finally the boy's plight became dangerous, and the diagnosis was sent to his parents—with the result that the patient received a mysterious summons. Timidly entering a small café as he was directed, he saw a man leaning over the table, his face buried in his hands. There was something excitingly familiar in that bent back . . . another moment, and father and son were in each other's arms; the elder explained, "I have come to fetch you."

Thus the boy smelled the beloved tannery once more, and was restored to his family. After the agony of separation, peace and rest filled the young heart of Louis Pasteur. Looking upward, he beheld a martial figure. General Baron Delort, Grand Cross of the Legion of Honor, marched over the Cuisane Bridge, totally oblivious that the revolution in the tannery below had been quenched by an acute attack of nostalgia.

Life flowed on agreeably in Arbois, but ambition pointed to sterner paths. Paris, however, seemed at the other end of the world to Pasteur, and he compromised on the college of Besançon; later, in taking his examinations before the Dijon Faculty, he was marked *médiocre* in chemistry, and out of twenty-two candidates who were declared admissible to the examinations for the École Normale, he was near the bottom of the list. Thus Pasteur's first venture from home ended in failure, and the second was not much more successful.

In his twentieth year, the provincial again attempted Paris; in answer to his parents' fears concerning the lure of the Latin Quarter, he wrote that when one wishes to keep straight, one can do so in this place as well as in any other. Pasteur's chief danger at this period was not indiscretion, but industry. Brought up out-of-doors, the open air knew him no longer, the boundless sky being exchanged for the dome of the Sorbonne. Before opening-hours and after closing-time, in empty libraries and deserted laboratories, a solitary figure could often be found, for Louis Pasteur had begun his career of work.

Pasteur already had a teacher who aroused his emotions to the highest pitch: the renowned chemist, Jean Baptiste Dumas. Like many of the builders of chemistry, Dumas began life as an apothecary—but modern commercialized pharmacy no longer produces this breed. At an age when youth is usually groping in uncertain mazes, Dumas walked directly to the temple of science, laying upon her altar his classic researches on uric acid and the composition of the blood.

Because of this work, a comet crossed the young man's path: Humboldt filled the student's attic in Geneva, and spoke to the entranced Dumas for a long time, telling him that if he came to Paris he could meet Laplace, Berthollet, Arago, Thénard, Cuvier, and Gay-Lussac. The comet disappeared, and Dumas came to Paris, rapidly mounting fame's difficult ladder. His classification of organic compounds into homologous series, his method for obtaining vapor density, and his remarkable revision of the atomic weights, are only a few of his innumerable researches, while Dumas' Law of Substitution ranks with Dalton's Atomic Theory and Mendeleyeff's Periodic Law as one of the three greatest contributions to the chemical philosophy of the nineteenth century.

Dumas was a dramatic teacher who turned his lecture-room at the Sorbonne into a theater, where hundreds of admiring spectators cheered and applauded. At the conclusion of the session, Pasteur seized his notebooks and hastened out with feelings that stirred him to tears. Once, while explaining the solidification of carbonic acid, Dumas asked for the loan of a handkerchief. The first to rush forward was Pasteur, whose handkerchief thus received the chemical snow; Dumas then returned the piece of linen, little thinking that it would be religiously preserved by his worshipper—but he lived long enough to read this incident in print.

Pasteur now lived only for the Experimental Method. Soon he had opportunity enough to apply all his devotion, for a subtle German chemist dropped a bombshell in the scientific circles of France. Ernst Eilhard Mitscherlich, professor of chemistry in the University of Berlin, famous for his discovery of isomorphism and dimorphism, flung this note into the lap of the Académie des Sciences:

> The paratartrate and the tartrate of soda and ammonia have the same chemical composition, the same crystalline form, the same angles, the same specific weight, the same double refraction, and consequently the same inclination of the optic axes. Dissolved in water, their refraction is the same. But while the dissolved tartrate causes the plane of polarized light to rotate, the paratartrate exerts no such action. M. Biot has found this to be the case with the whole series of these two kinds of salts.

This communication caused somewhat of a scientific panic, for ambushed in this innocent-appearing note were riddles that none could unravel: not Mitscherlich himself, though he was the founder of modern crystallography; not old Biot, though he was founder of molecular dissymmetry. Who indeed could solve a paradox unknown to Arago and unfinished by Malus? The leading chemists and physicists of the time sighed over Mitscherlich's note—and tackled other problems.

But Pasteur memorized Mitscherlich's note, and resolved to write the answer in his laboratory. For days he disappeared from the world—already he was a neophyte in the temple of investigation. At times he was seen passing the house where Malus had lived—Malus who gained immortality by discovering the polarization of light, and then perished in his prime from phthisis. One day Pasteur rushed from his laboratory in agitation; embracing the first man he met in the corridor, he began to talk to him in intense excitement—there was one enigma less in the world, for Pasteur now knew the secret in Mitscherlich's note.

Pasteur's researches in crystallography began to be talked about. He found an efficient advertising agency in one of his teachers, Antoine Jerome Balard. This chemist climbed to eminence over a salt-marsh, for there in his twenty-fourth year he discovered bromine. Balard, bursting with Southern vivacity—he hailed from Montpellier—was usually in a ferment. His explanation, "Potash, which—potash, then—potash, in short, which I now present to you," is a celebrated contribution, not to chemistry, but to impetuosity. As Pasteur's discoveries more and more excited Balard's enthusiasm, he became a voluble volcano: wherever Balard went, Pasteur's crystals were on his lips. He informed Dumas of what their mutual pupil had achieved. He attempted to argue with old Biot, but here the volcano met an iceberg; Biot, who had spent most of his long life in epoch-making researches on the polarization of light, had heard too often the cry of promising Galileos and budding Newtons, and to Balard's torrent of words, he coldly interposed, "I should like to investigate that young man's results."

The meeting between Pasteur and Biot was historic: Pasteur was in his twenties, and Biot in his seventies—the gulf of half a century stretched between the two scientists. Pasteur was guileless, simple-minded, open-hearted: Biot was suspicious, ironical, quizzical. In the course of his extensive experience with human beings he had lost all his illusions, and had shed all his enthusiasms except his love for science. The test took place in Biot's private kitchen, with salts that Biot himself furnished, and solutions that Biot himself prepared. The experiments lasted over a period of several days, every step being watched by Biot. The result of these interviews has often been told; how Biot, finally convinced that the stripling before him had made a great discovery, gently approached Pasteur, and said in a voice full of emotion, "My dear boy, I have loved science so much during my life, that this touches my very heart."

Biot, who possessed an instinct for climaxes, brought together the man who had upset the crystallographers, and the man who had solved the difficulties. "My young friend," said Biot, introducing Pasteur to Mitscherlich, "you may boast of having done something great, in having discovered what had escaped such a man as this."

Biot could look back upon unforgettable events: in his young days he had corrected the proof-sheets of Laplace's *Mécanique Céleste,* and when Gay-Lussac first arose in the air, within the balloon sat Biot. It was Pasteur who furnished Biot his last thrill, and the long-closed heart expanded with a new warmth. In the old misanthrope, Pasteur found a second father. In time the two fathers met, and in scientific annals we know nothing more beautiful or touching than the courteous treatment which the illustrious physicist extended to the simple tanner. The following letter, written to Joseph Pasteur by Biot exhibits the growling old watchdog of Science in a kindlier light than most of his contemporaries knew him:

> Sir, my wife and I very much appreciate the kind expressions in the letter you have done me the honor of writing me. Our welcome to you was indeed as hearty as it was sincere, for I assure you that we could not see without the deepest interest such a good and honorable father sitting at our modest table with so good and distinguished a son. I have never had occasion to show that excellent young man any feelings but those of esteem founded on his merit, and an affection inspired by his personality. It is the greatest pleasure that I can experience in my old age, to see young men of talent working industriously and trying to progress in a scientific career by means of steady and persevering labor, and not by wretched intriguing. That is what has made your son dear to me, and his affection for me adds yet to his other claims and increases that which I feel for him. We are therefore even with one another. As to your kindness in wishing that I should taste fruit from your

garden, I am very grateful for it, and I accept it as cordially as you send it.

It happened during his crystal period that Pasteur received an appointment in chemistry at Alsace. Here he lived in the home of his jovial friend, Bertin, the professor of physics. Pasteur, whose capacity for work amazed his easy-going colleague, once convulsed him with merriment by his involuntary exclamation, "Ah! formate of strontian, if only I had got you!" Bertin occasionally visited the Rector of the Academy of Strassburg, and with much gusto explained to the family group that he had a young friend whose only interest in life was the study of crystals. During one of Pierre Bertin's pronouncements that Pasteur loved science exclusively, it must have been the Rector's turn to be amused, for on his desk lay the following letter, written just fourteen days after the writer's arrival in Strassburg:

Sir—An offer of the greatest importance to me and to your family is about to be made to you on my behalf; and I feel it my duty to put you in possession of the following facts, which may have some weight in determining your acceptance or refusal.

My father is a tanner in the small town of Arbois in the Jura, my sisters keep house for him, and assist him with his books, taking the place of my mother whom we had the misfortune to lose in May last.

My family is in easy circumstances, but with no fortune; I do not value what we possess at more than 50,000 francs, and, as for me, I have long ago decided to hand over to my sisters the whole of what should be my share. I have therefore absolutely no fortune. My only means are good health, some courage, and my position in the Université.

I have left the École Normale two years ago, an *agrégé* in physical science. I have held a Doctor's degree eighteen months, and I have presented to the Académie a few works which have been very well received, especially the last one, upon which a report was made which I now have the honor to enclose.

This, Sir, is all my present position. As to the future, unless my tastes should completely change, I shall give myself up entirely to chemical research. I hope to return to Paris when I have acquired some reputation through my scientific labors. M. Biot has often told me to think seriously about the Institute; perhaps I may do so in ten or fifteen years' time, and after assiduous work; but this is but a dream, and not the motive which makes me love Science for Science's sake.

My father will himself come to Strassburg to make this proposal of marriage. Accept, Sir, the assurance of my profound respect, etc.

P.S.—I was twenty-six on December 27.

After some deliberation, the Rector permitted his daughter to accept this hasty offer; and whether or not we credit the rather stale story that on the wedding-day someone ran to Pasteur's laboratory to inform him it was time to get married, one fact remains undisputed: in the history of human marriage, since the day of the first mating between man and woman, there has never been a more perfect union than that which consecrated the lives of Louis Pasteur and Marie Laurent.

After the wedding Pasteur immediately went back to his crystals. His home was a chapel where he communed with his beloved ones, but the laboratory ever remained the temple where he spoke to Nature as no man had ever done before. Pasteur's search for racemic acid at a time when its origin was a mystery and its production an accident; his ultimatum, "I shall go to Trieste. I shall go to the end of the world. I must discover the source of racemic acid, I must follow up the tartrates to their origin"; his pursuit of this elusive acid in Leipzig, Zwickau, Dresden, Freiberg, Vienna and Prague; his note to his wife, "I will pursue it for ten years, if need be"; his final triumphant telegram to Biot, "I transform tartaric acid into racemic acid—please inform MM. Dumas and Senarmont," have all become a part of the romance of modern science. His completed researches in molecular dissymmetry, a generation later gave birth to that new science which Victor Meyer named stereoisomerism.

When Pasteur, breaking a tartrate crystal and plunging it back into the mother liquid, saw the crystal completely restored and compared this trauma to a wound which is healed with the aid of new molecules, he demonstrated how his luminous mind passed logically from physics to the threshold of physiology; when Pasteur, noticing a solution of ammonium tartrate grow cloudy, observed that a drop from the infected flask produced putrefaction in a new flask, he naturally moved onward from chemistry to the inner recesses of biology. Pasteur was a scryer whose crystal-gazing showed vaster horizons for humanity.

In order to realize the darkness that surrounded the entire subject of fermentation, it is only necessary to recall the prevailing views of the period as enunciated by Liebig:

> Those who attempt to explain the putrefaction of animal substances by the presence of animalcules, argue much in the same way as a child who imagines he can explain the rapidity of the Rhine's flow by attributing it to the violent agitation caused by the numerous water-wheels of Mainz, in the neighborhood of Bingen. Can we legitimately regard plants and animals as the means whereby other organisms are destroyed, when their own constituent elements are condemned to undergo the same series of putrefaction phenomena, as the creatures which preceded them? If the fungus is the agent in the oak's destruction, if the microscopic animalcule is the agent in the putrefaction of the elephant's carcass, I ask in my turn, what is the agent which works the putrefaction of the fungus and the microscopic animalcule when life has been removed from these two organized bodies?

With these picturesque and contemptuous words, Justus von Liebig, the dominant chemist of his day, sought to close the door on that invisible world which the microscope of Pasteur opened to science. In the ensuing battles which were waged between the two champions, Liebig, although only nineteen years the senior of Pasteur, was so hopelessly superannuated that he refused to look through a microscope—and yet he was the father of laboratory teaching in chemistry. He belonged to the pre-microbic era of science, and thus seems as antiquated as Van Helmont. Bacteriology was the bridge that divided the old land from the new, and only those who crossed that bridge found themselves on modern ground.

Each discovery of Pasteur served as a stepping-stone to further discoveries. Various observers, such as Eberth, Ogston, Ducrey, live in scientific history because it was their fortune to isolate a single microbe, but in the multiplicity of Pasteur's achievements, who remembers that he was the first to observe the staphylococcus and the pneumococcus? He overthrew an army of theories by his announcement that certain organisms not only do not require oxygen, but are destroyed by its presence. This discovery of anaerobic life is a glorious passport to fame, and yet in the matchless career of Pasteur it is merely an incident crowded amongst greater triumphs.

Pasteur was now led—not because he desired it, but because the inexorable march of facts demanded it—face to face with the Sphinx-riddle of science, the ever-unsolvable question of spontaneous generation. It was a field over-fertile for speculation, but barren for science. The problem seemed to belong to the Unknown, where the scientist should not enter, since he could not hope to return with evidence. Pasteur's chief friends heard with dismay that he stood before the query of the ages. "I would advise no one to dwell too long on such a subject," said Dumas. "You will never find your way out," protested Biot. Yet Pasteur felt he could not evade the issue, and wrote to his father: "God grant that by my persevering labors I may bring a little stone to the frail and ill-assured edifice of our knowledge of those deep mysteries of Life and Death where all our intellects have so lamentably failed."

Lifting hidden veils, Pasteur advanced to the outermost boundaries of human knowledge; in spite of the doubts of friends, in spite of the rage of opponents, he came back with final proof of the fallacy of abiogenesis. As an example of Pasteur's laboratory methods, we may quote one of his convincing experiments that microörganisms cannot arise *de novo;* the concluding passage burns with the fire of genius, the impassioned prose glows with a poet's fervor:

> Here is an infusion of organic matter, as limpid as distilled water, and extremely alterable. It has been prepared to-day. To-morrow it will contain animalculæ, little infusories, or flakes of moldiness.
>
> I place a portion of that infusion into a flask with a long neck, like this one. Suppose I boil the liquid and leave it to cool. After a few days, moldiness or animalculæ will develop in the liquid. By boiling, I destroyed any germs contained in the liquid or against the glass; but that infusion being again in contact with air, it becomes altered, as all infusions do.
>
> Now suppose I repeat this experiment, but that, before boiling the liquid, I draw (by means of an enameler's lamp) the neck of the flask into a point, leaving, however, its extremity open. This being done, I boil the liquid in the flask, and leave it to cool. Now the liquid of this second flask will remain pure not only two days, a month, a year, but three or four years—for the experiment I am telling you about is already four years old, and the liquid remains as limpid as distilled water.
>
> What difference is there, then, between those two vases? They contain the same liquid, they both contain air, both are open! Why does one decay and the other remain pure? The only difference between them is this: in the first case, the dusts suspended in air and their germs can fall into the neck of the flask and arrive into contact with the liquid, where they find appropriate food and develop; thence microscopic beings. In the second flask, on the contrary, it is impossible, or at least extremely difficult, unless air is violently shaken, that dusts suspended in air should enter the vase; they fall on its curved neck. When air goes in and out of the vase through diffusions or variations of temperature, the latter never being sudden, the air comes in slowly enough to drop the dusts and germs that it carries at the opening of the neck or in the first curves.
>
> This experiment is full of instruction; for this must be noted, that everything in air save its dusts can easily enter the vase and

come into contact with the liquid. Imagine what you choose in the air—electricity, magnetism, ozone, unknown forces even, all can reach the infusion. Only one thing cannot enter easily, and that is dust, suspended in air. And the proof of this is that if I shake the vase violently two or three times, in a few days it contains animalculæ or moldiness. Why? because air has come in violently enough to carry dust with it.

And, therefore, gentlemen, I could point to that liquid and say to you, I have taken my drop of water from the immensity of creation, and I have taken it full of the elements appropriated to the development of inferior beings. And I wait, I watch, I question it, begging it to recommence for me the beautiful spectacle of the first creation. But it is dumb, dumb since these experiments were begun several years ago; it is dumb because I have kept it from the only thing man cannot produce, from the germs which float in the air, from Life, for Life is a germ and a germ is Life. Never will the doctrine of spontaneous generation recover from the mortal blow of this simple experiment.

After this adventure into the origin of life, Pasteur turned his attention to the maladies of wine; again pursuing the microbe, he saved from threatened ruin one of the most important industries of his country. This was succeeded by an investigation of the diseases of beer, demonstrating both the cause and cure. The famous process of Pasteurization was born in a brewery.

While thus continuing his studies in putrefactive phenomena, Pasteur was unexpectedly deflected from his path by an ailing silkworm. The South of France lives on the silkworm. Throughout entire districts, the customary greeting is not "How are you?" but "How are your silkworms?" When the silk-swollen worms climb upon the litters to become chrysalids, it is a day of festival for the populace who worship the mulberry as the Tree of Gold. But when the worms refuse to eat and languish and die, the people look into their own graves.

For quite a period flourishing France indeed wove silk into gold, unapprehensive of coming disaster. But for over four thousand years the silkworm has been reared under highly artificial conditions, the cultivator thinking not of the health of the *Bombyx mori,* but solely of its miles of silk. In the mid-nineteenth century, nature took a terrible revenge. Especially in France the silkworm epidemic reached such proportions that whole plantations were abandoned in despair and destitution. The following note, written in the early sixties, is the funeral dirge of an afflicted country:

> The traveler who some fifteen years ago traversed the Cevennes mountains and retraces his steps to-day, would be astonished and greatly moved by the changes of all descriptions which have taken place in so short a space of time in the district.
>
> Formerly he saw on the slopes of the hills active and sturdy men busy quarrying the rock, building solidly constructed walls out of the débris, destined to support fertile soil prepared with infinite labor, and carried thus to the summit of the hills in carefully laid-out terraces, upon which mulberry trees were planted. These men, despite the fatigues of such hard work, were happy and contented, for comfort surrounded their domestic hearth.
>
> To-day these plantations of mulberry trees are completely abandoned; the golden tree no longer enriches the country, and there, faces formerly radiant, are now melancholy and sad; where before plenty reigned, now misery and poverty prevail.

The situation was so acute, that several thousand proprietors in the silk-producing regions signed a petition requesting official intervention. The chemist Dumas, being too versatile to confine his activities to acids, had entered politics in later life, becoming a member of the national legislative assembly, minister of agriculture and commerce, president of the municipal council, and master of the French mint. Dumas, who was born at the foot of the Cevennes mountains at Alais, where the silkworm disease was at its worst, reported to the Senate: "Eggs, worms, chrysalids, moths, all are affected by the disease. Whence does it come? Nobody knows. How is it communicated? That is also unknown."

France looked to Dumas for succor; and Dumas, now sixty-five years of age, had an audacious inspiration: he asked Pasteur to give up his studies, to leave his laboratory, and to come to Alais to fight this inexplicable scourge. Never before had Pasteur been so thunderstruck. "I have never even touched a silkworm!" he cried. Returning to the laboratory, he said to Emile Duclaux, one of his favorite pupils, "Do you know what M. Dumas has just asked me to do? He wants me to go into the South and study the disease of silkworms." The two scientists looked at each other in mutual astonishment. "Is there then a disease of silkworms," they asked, "and are there countries ruined by it?" It seemed impossible to forsake the life-work that lay so clearly before him, but how could he resist the voice of his revered master that penetrated through the laboratory walls: "The distress is beyond anything you can imagine."

Upon Pasteur's arrival in the South, every peasant boy could have given him lessons in silkworms. Pasteur went to the wise and humble man who wrote: "Because I have shifted a few grains of sand upon the shore, am I in a position to understand the abysmal depths of ocean? Life has unfathomable secrets. Human knowledge will be erased from the world's archives before we know the last word concerning the gnat." Pasteur asked Henri Fabre to show him some cocoons. And the entomologist brought him a handful. Pasteur shook them saying, "Why, there is something inside." "The chrysalis," replied Fabre. "What is a chrysalis?" asked Pasteur. "A sort of mummy into which the caterpillar changes before becoming a moth." "Is there one of these things inside of every cocoon?" asked Pasteur. "Certainly, it is to protect the chrysalis that the caterpillar spins its cocoon." "Ah," said Pasteur, and he thanked the king of the insect world.

At Alais, all was confusion. Advice, suggestions, appeals and contradictions were in the air. But while cultivators argued about the reasons for stunted worms, the menace spread into nation after nation until it seemed as if the silkworm might disappear from the earth. Into this obscurity Pasteur entered with his microscope, and soon wrote to his wife: "I have some ideas on this disease, which is indeed a scourge for all those southern departments. The one *arrondissement* of Alais has lost an income of 120,000,000 francs during the last fifteen years. M. Dumas is a million times right; it must be seen to, and I am going to continue my experiments."

After exhausting himself in finding the etiology and prevention of pébrine, it was agony for him to discover there was a second disease, flacherie, which must likewise be conquered. The diseases of silkworms thus imprisoned Pasteur for five years. But in the end he found out everything. When a commission asked him for a sample of guaranteed graine, or silkworm eggs, Pasteur sent four boxes with this prophecy: the first lot is healthy and will succeed; the second lot will perish exclusively from pébrine; the third lot will succumb solely to flacherie; the fourth lot will die partly from pébrine, and partly from flacherie.

Every egg acted exactly as Pasteur had predicted. The mystery of centuries was dispelled. Joy returned to the South of France; once again was heard the munching of the mulberry leaves by countless worms; again they spun their silken cocoons, spinning contentment for the people.

Pasteur was the savior of sericulture, and in life's prime heard praise which is usually reserved for obituary notices. Personally, however, he was already a man of sorrows. His mother died while he was yet at the threshold of his unequaled career; his father, a sergeant under Napoleon who granted him the Legion of Honor on the field of battle, saw his son, at the age of thirty, receive the Legion of Honor in the field of science, and lived long enough to witness many other triumphs, yet so loving was their relationship, that when the old soldier-tanner passed away, Pasteur was inconsolable, and sitting alone in the silent tannery he wrote an incomparable letter to his family.

We have quoted an extract from one of Pasteur's lectures to exhibit his greatness; let us quote this letter to show his goodness:

> Dear Marie, dear children, the dear grandfather is no more; we have taken him this morning to his last resting place, close to little Jeanne's. In the midst of my grief I have felt thankful that our little girl had been buried there. . . . Until the last moment I hoped I should see him again, embrace him for the last time . . . but when I arrived at the station I saw some of our cousins all in black, coming from Salins; it was only then that I understood that I could but accompany him to the grave.
>
> He died on the day of your first communion, dear Cécile; those two memories will remain in your heart, my poor child. I had a presentiment of it when that very morning, at the hour when he was struck down, I was asking you to pray for the grandfather at Arbois. Your prayers will have been acceptable unto God, and perhaps the dear grandfather himself knew of them and rejoiced with dear little Jeanne over Cécile's piety.
>
> I have been thinking all day of the marks of affection I have had from my father. For thirty years I have been his constant care, I owe everything to him. When I was young he kept me from bad company and instilled into me the habit of working and the example of the most loyal and best-filled life. He was far above his position both in mind and in character. . . You did not know him, dearest Marie, at the time when he and my mother were working so hard for the children they loved, for me especially, whose books and schooling cost so much. . . . And the touching part of his affection for me is that it never was mixed with ambition. You remember that he would have been pleased to see me the headmaster of Arbois College? He foresaw that advancement would mean hard work, perhaps detrimental to my health. And yet I am sure that some of the success in my scientific career must have filled him with joy and pride; his son! his name! the child he had guided and cherished! My dear father, how thankful I am that I could give him some satisfaction!
>
> Farewell, dearest Marie, dear children. We shall often talk of the dear grandfather. How glad I am that he saw you all again a short time ago, and that he lived to know little Camille. I long to

see you all, but must go back to Alais, for my studies would be retarded by a year if I could not spend a few days there now.

This letter was written with a fateful pen, which scratched the names of little Jeanne who was already dead, and of little Camille and Cécile who still smiled upon life. Alas, within a very short time both Cécile and Camille were also dead. Typhoid slew the daughters of Louis Pasteur. It was a famous but unhappy man who for the third time carried a little girl's coffin to Arbois.

Another catastrophe awaited Pasteur. As a result of his herculean labors among the silkworms, combined with merciless criticisms from numerous sources before his experiments were completed, he was stricken with a hemiplegia of such severity that all who saw him expected a fatal termination. The body was helpless, yet his mind remained untouched. Some of his final observations on the silkworm problem were dictated while the paralyzed man sat in an arm-chair with his pupils around him. Slowly the paralysis lifted, but never entirely, and for years to come, one of the greatest figures in modern science moved through the laboratories with a stiffened hand and limping foot.

During the protracted convalescence, a footman came every morning to Pasteur's house, and quietly departed with a sealed envelope. The information was for Napoleon III, who was astute enough to realize Pasteur's value to France. In 1863 the Emperor had invited the scientist to the Tuileries. This was the second time that a Pasteur entered a palace: the first was in 1763, exactly one hundred years previous, when his great-grandfather, the serf Claude Pasteur, came to the palace of his master, the Count of Udressier, and with a bag of gold purchased his freedom.

The interviews between Louis Pasteur and Louis Napoleon were meetings between the forces of good and evil. Pasteur was the best man that France produced, and Napoleon III was the worst since Louis XIV. The crimes of Le Grand Monarque, such as the Revocation of the Edict of Nantes, and the rape of

Alsace-Lorraine, found no parallel until Napoleon le Petit massacred the bravest of Garibaldi's red-shirts, restored the papacy, destroyed the Roman Republic, overthrew France with the coup d'état, and polluted her with his intrigues for twenty years. This unscrupulous man, obsessed with the name of Napoleon, attempted to recarve the map of Europe, and might have succeeded if the grim Bismarck had not lived across the border.

The schemes of these two rulers of men culminated in one of the unforgettable tragedies of Pasteur's life—the Franco-Prussian War. Within a few weeks France, which had been long debauched by the emperor, lay prostrate before her enemy. Pasteur never forgave Germany for humiliating his country. He returned his honorary medical diploma to the University of Bonn with words that even to-day sting like fuming sulphuric. Pasteur survived the Franco-Prussian War for twenty-five years, but never would accept a decoration from the German government. "If science has no country, the scientist has," was his response. It is deplorable that on the international field of science, a Pasteur should have sown the dragon's teeth of patriotism. In view of this hostility, it is pleasant to find that one of the most earnest tributes to Pasteur emanated from a German source; the words of Max Schottelius of Freiberg have hitherto not appeared in English, and for this reason are now presented:

> Historians in calling the period at the close of the Middle Ages "the age of the great discoveries and inventions," do so in view of the influence exercised upon cultural life by the opening up of new worlds and the invention of new instruments. When one day the nineteenth century is to be designated as the age of practical sciences, the name of Louis Pasteur will be revered as one of the greatest figures of this period.
>
> The great nations of the East, just awakening from their long sleep, those branches of the human family which are now at the threshold of their cultural development, will one day realize the blessings for which this period of practical scientific investigation has prepared the soil and planted the seeds. And then the far-

reaching influences of Louis Pasteur's life-work will be recognized in a measure which we of to-day are unable to appreciate. Then his name will be pronounced with the same feelings which are evoked in us on hearing the name of Archimedes.

The child of humble French parents, his success was entirely due to his own genius, his efforts, his indefatigable industry. There is really nothing original in science: every thought, if it be logical at all, though apparently new, rests on the efforts of preceding investigators. But if ever a scientist succeeded in generating fruitful ideas in his own brain, and if we are permitted to use the expression originality in its true sense, then it must be bestowed upon Louis Pasteur. With an incomparable logic and perseverance he followed his course as if in obedience to a natural law; he carried out his plan with a consistency, that now, after his life has come to a close, we must say: Pasteur *had* to follow this course—he could not do otherwise!

Proceeding from the stages of earth's development, from a study of the laws governing the formation of crystals, his work culminated in the fight against disease.

Pasteur's historical significance lies not so much in his actual results as in the fact that his results are founded on a sound scientific basis. And this foundation is so solid, the ground plan is drawn with such an exactitude that centuries to come will be able to build on it.

In doing homage to the memory of this great scientist, it is not necessary to enumerate all his literary works quoted in innumerable medical books, and the rays emanating from his investigations having reached the farthest circles of scientific research. There is no branch of science and no department of industry which in one way or the other has not been advanced by Pasteur's discoveries.

It would be superfluous to recall the fact that Lister for his protective dressing was indebted to Pasteur's investigations on the air-dust and its infectious nature. In doing this, one might be liable to repeat the old error and assert that to air-carried microörganisms are to be ascribed infective qualities—a view long ago refuted by a series of experiments carried out at the Pasteur Institute. There is no such thing as infection by air, but only through contact with liquid or solid bodies!

But if we remember how until recently epidemiology was dominated by the theory of "air infection," it appears quite conceivable that the discovery of living ferments and the demonstration of viable germs in the atmospheric air would suggest the idea that infectious diseases are transmitted in this manner. After Ehrenberg's discovery of the infusoria, similar ideas had become current and were still in vogue at the time when the results of Pasteur's investigations were being published.

It is just the latter instance which reveals the typical character of Pasteur's scientific activities: he was not satisfied with the mere stating of scientific facts, which is often erroneously praised as "pure science," but he directly went to the interpretation and practical utilization of every newly discovered fact. In this manner he protected himself and his school against the uncritical accumulation of facts as well as the useless construction of sterile hypotheses. Pasteur knowing too well that both roads lead to the Scylla and Charybdis of true scientific knowledge, he steadfastly kept the right middle course.

There is never to be noted a standing-still in Pasteur's researches, never a reposing on past achievements; in his work, the next achievement is always the result of the foregoing, and by a wise utilization of the established facts, he proceeded to new and ever larger accomplishments.

After disposing of the theory of spontaneous generation and putting in its place the doctrine of the living ferments, one of the practical results of which was a more rational preparation of bread, there followed works in the field of pathology: the recognition of and the successful battle with "pébrine," a microparasitic disease of silkworms, and then his findings regarding the changing qualities of the lower organisms, which found their significant expression during the memorable discussion on anthrax at the Congress of Geneva, in the year 1882. It was there that the opposing tendencies between Koch's and Pasteur's school reached their climax in their sharp disagreement regarding protective inoculation against anthrax. The fact that to-day this procedure is successfully employed, demonstrates its usefulness.

Pasteur's laboratories furnished not only the protective lymphs against animal infectious diseases, such as chicken cholera, symptomatic anthrax, swine erysipelas, but here the initial attempts were made at developing on a strictly scientific basis a protective inoculation against hydrophobia in man.

Some criticized Pasteur for selecting rabies, a comparatively rare disease, as the object of his investigations. In rejecting these objections, we should take into consideration that hydrophobia is quite frequent in France, and especially in Paris, and furthermore, on the ground of his experiences, Pasteur was in the position to know better than anybody else which one of the infectious diseases affecting man should be attacked first. The daily political papers raised a hue and cry whenever a case of hydrophobia had terminated fatally "on account of inoculation," but no scientist ever spoke a word against Pasteur's inoculations in cases of hydrophobia. Pasteur continued to elaborate the great problems of science to the limits of his powers, until at last Nature put an end to his labors.

In judging a man's life we often must "separate the person from his cause." This does not apply to Pasteur, in whom the man and the scientist were one. Unselfishness and modesty, which seem to be characteristic of all truly great men, were outstanding features of his nature. Whosoever came in personal contact with Pasteur and saw his deep sympathy with his patients, cannot but remember him with the profoundest admiration.

There never were scenes witnessed in any waiting-room similar to those seen in that of Pasteur, during the time of the practical introduction of inoculation against rabies. No adequate description can be given of the expression of anxiety, of impatient expectation, of hope depicted in the faces of the crowd representing all the races of mankind. Pasteur devoted to all of them his personal attention and consoled them not only by words but by deeds of practical helpfulness. One saw the solicitude of the master, the joy he felt over every successful case, and how in the personal treatment he gave to his patients, he appeared to be wholly oblivious of the theoretical side of his experiments.

All his activities, his struggles for enlightenment, were impelled by a fervent love for truth which often expressed itself in an almost exaggeratedly severe critique of the scientific findings of others, and especially in an unsparing attitude toward his own achievements.

In those days, how firmly did Pasteur hold to the belief in a rabies bacillus, how earnestly did he strive to find a tangible organism as a basis for his inoculations! Discontented with himself and the insufficiency of the means at his disposal, he always bowed down before truth, and however seducing dubious findings may have appeared—the bacillus could not be found.

Whosoever had the pleasure of knowing Pasteur personally, must have been impressed by his sincerity and simplicity. He was a true man, endowed with all that is good in human nature, and fortunate is to be called the land which has produced the son such as was Louis Pasteur.

Ever since Pasteur had sent, in the summer of 1857, his paper on Lactic Acid Fermentation to the Lille Scientific Society, his mind tended to the conviction that in the world of the "infinitely small" lay buried the secret of contagious diseases. After his first interview with Louis Napoleon, he said, "I assured the Emperor that all my ambition was to arrive at the knowledge of the causes of putrid and contagious diseases." Not by training, but rather by evolution, this chemist became a medical man. For several years Pasteur felt that his place was in the Academy of Medicine; after the Franco-Prussian War, when a vacancy occurred, he became a candidate, and was elected by a majority of a single vote.

It would have been better for his peace of mind, if he had been overwhelmingly defeated. Since few men have opened so many new paths as Pasteur, few men have endured so much opposition. Even after a subject had undergone the most rigorous proof, being incontestably settled by the experimental method, rhetorical individuals arose in detraction of Pasteur. Usually Pasteur exhibited superhuman patience. For example, in order to clarify the complexities of molecular dissymmetry to certain noisy contenders who should have seen the light long ago, he called for a cabinet-maker and instructed him to fashion a gigantic set of the crystalline varieties of the tartrates —and Emile Duclaux asked him why he did not conclude the session by hurling these wooden crystals at his adversaries' heads! Pouchet and Joly attempted to block the path of Pasteur for years, and men like Colin and Peter will live in scientific history solely because they were vicious enemies of him who walked continually toward truth. At times, however, Pasteur was a terrible opponent, and his exclamation, "What you lack, M. Frémy, is familiarity with a microscope, and you, M. Trécul, are not accustomed to laboratories!"—was an indictment not easily forgotten.

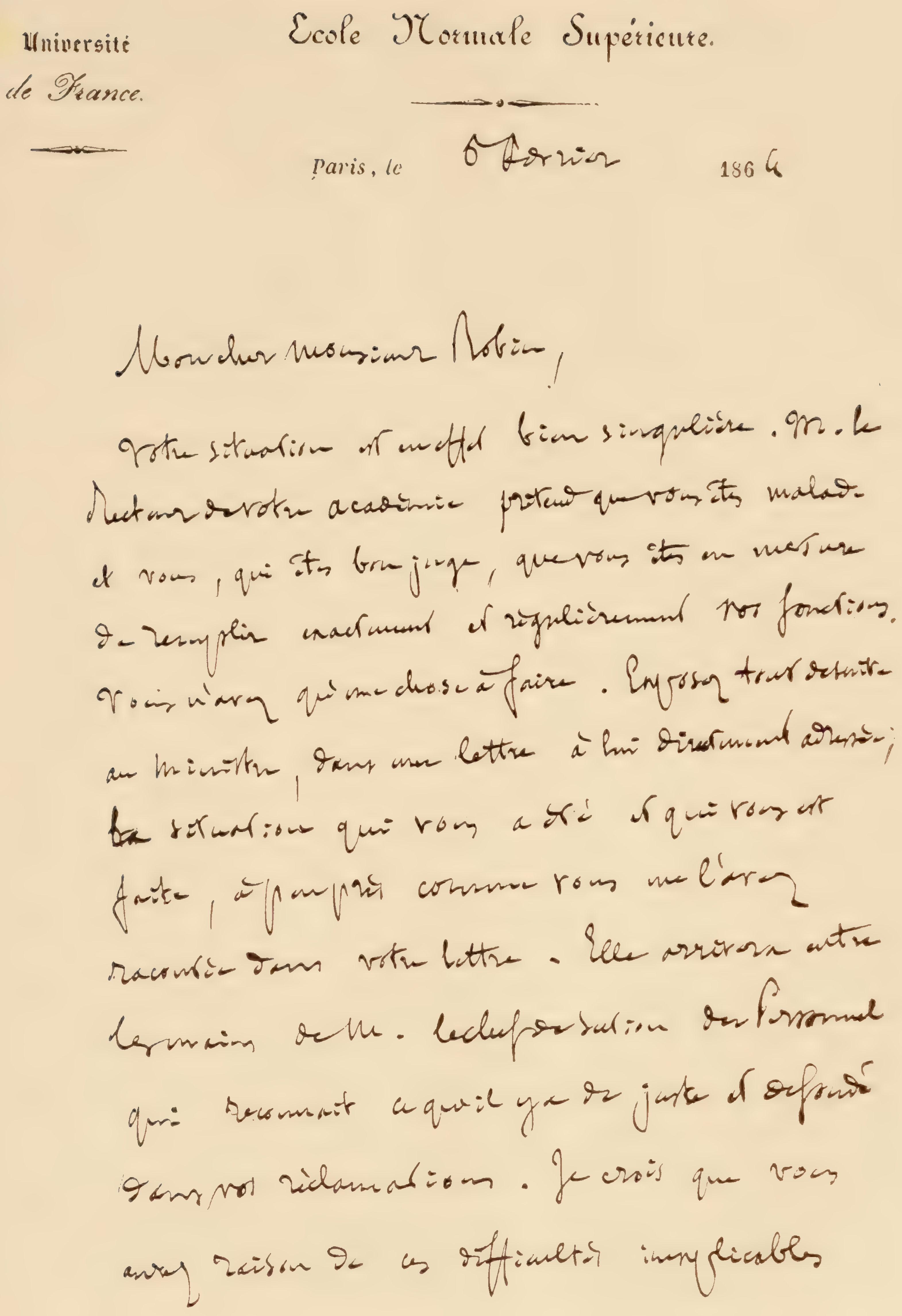
All the truculent argumentation which hitherto interfered with his onward progress, was as nothing compared with the enmity which greeted him when he came among the doctors. To Pasteur the Academy of Medicine was an armed camp, bristling with prejudice and surrounded by error. Physicians and surgeons who have gone down to nameless dust, resented instruction from a chemist, a non-practitioner, a layman after all. When Pasteur presented facts, their answer was: Monsieur, where is your M.D.? The leading academicians, men who are still remembered by historians, Chassaignac, Piorry, Pidoux, denounced the germ theory of disease in the most scathing and ironical language of which Frenchmen are capable. To-day their words read like chapters out of a mediæval book. Jules Guérin raved against vaccines, while Pasteur demonstrated their value: in the angry dispute that followed, Jules Guérin, at the age of eighty, became so enraged that he rushed at Pasteur, challenging him to a duel. Louis Pasteur stuck to his seat at the Academy of Medicine: it was his function to force the germ theory down the throat of medical France.

While Pasteur's opponents were denying that germs bore any relationship to infections, the bacillus anthracis which from ancient times had destroyed cattle everywhere, grew especially virulent throughout France. Entire herds staggered and perished miserably within a few hours, their distended carcasses crowding the pastures. A malignant deity seemed at work, for there were times when a shepherd, seeing his flock quietly grazing, would lie dreaming on the hill-slope; when he arose to take the flock home, death was spread all around him. If the shepherd then scratched his hand on one of his stricken sheep, he died among his flock.

So Pasteur, the master-shepherd, came to the sheepfolds of Chartres. Again he faced the unknown, and after years of effort Pasteur held the answer in a little vial. He announced that by an attentuated virus he could prevent anthrax. Half a hundred sheep were inoculated with an extremely virulent anthrax culture, and half of these were vaccinated and half were not. "The twenty-five unvaccinated sheep will all perish," said Pasteur, "the twenty-five vaccinated ones will all survive."

Pasteur's bold prediction was received with general incredulity; there were some Pasteurians whose faith in him was absolute, but many of his friends were uneasy at the sublime audaciousness with which he risked the reputation of a lifetime, while the Colins were certain that at last he would be discredited. The crucial test occurred, and before long the most disquieting symptoms appeared: some of the vaccinated sheep developed fever and edema, and one lamb was lame. Hour by hour the rumors grew worse. At night he received a note which staggered him: one of the vaccinated sheep was reported dying. The destiny of agriculture and the fate of preventive inoculation depended on that sheep. Pasteur's anxiety was pitiful. The disciples around the master for the first time saw the shadows of doubt in those sad, grave eyes. Would the old magician's last trick fail?

Morning came, and the whole excited veterinary world seemed to be at that farmyard, watching the result. Everyone likes to be present when history may be made. Never did the Experimental Method gain a more brilliant victory. Not a single sheep went wrong. The twenty-five unvaccinated sheep lay dead from anthrax, the twenty-five vaccinated ones browsed in perfect health. Jennerian vaccination was surpassed. As Pasteur approached that farmyard at Pouilly-le-Fort, a cheer arose, but the Father of Preventive Medicine did not hear. Among the sheepfolds he beheld a vision of Humanity freed from all infectious diseases.



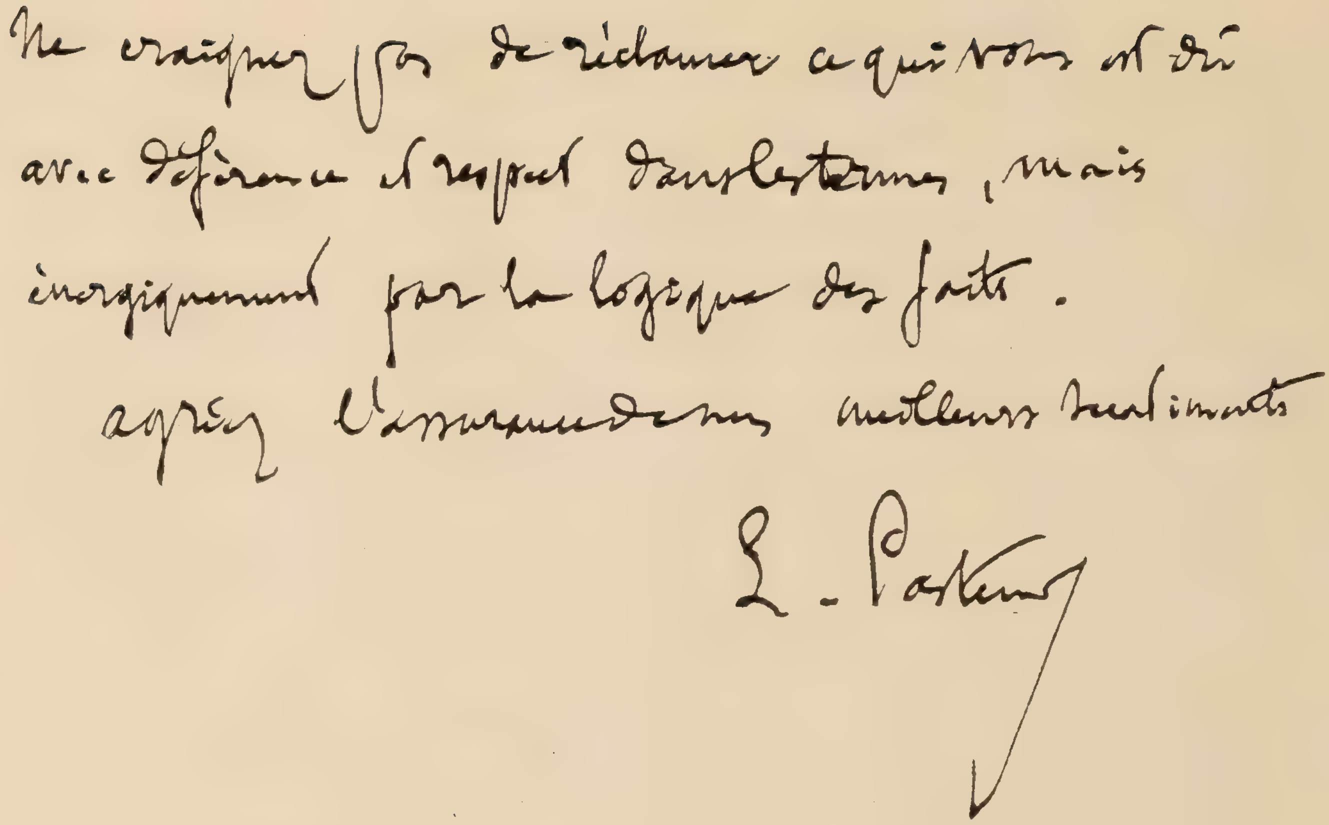
Université
de France.

Ecole Normale Supérieure.

Paris, le 6 février 1864

Mon cher monsieur Robin,

Votre situation est en effet bien singulière. M. le Recteur de votre académie prétend que vous êtes malade et vous, qui êtes bon juge, que vous êtes en mesure de remplir exactement et régulièrement vos fonctions. Vous n'avez qu'une chose à faire. Exposez tout de suite au Ministre, dans une lettre à lui directement adressée, la situation qui vous a été et qui vous est faite, à peu près comme vous me l'avez racontée dans votre lettre. Elle arrivera entre les mains de M. le chef de division du Personnel qui reconnait ce qu'il y a de juste et de fondé dans vos réclamations. Je crois que vous avez raison de ces difficultés inexplicables

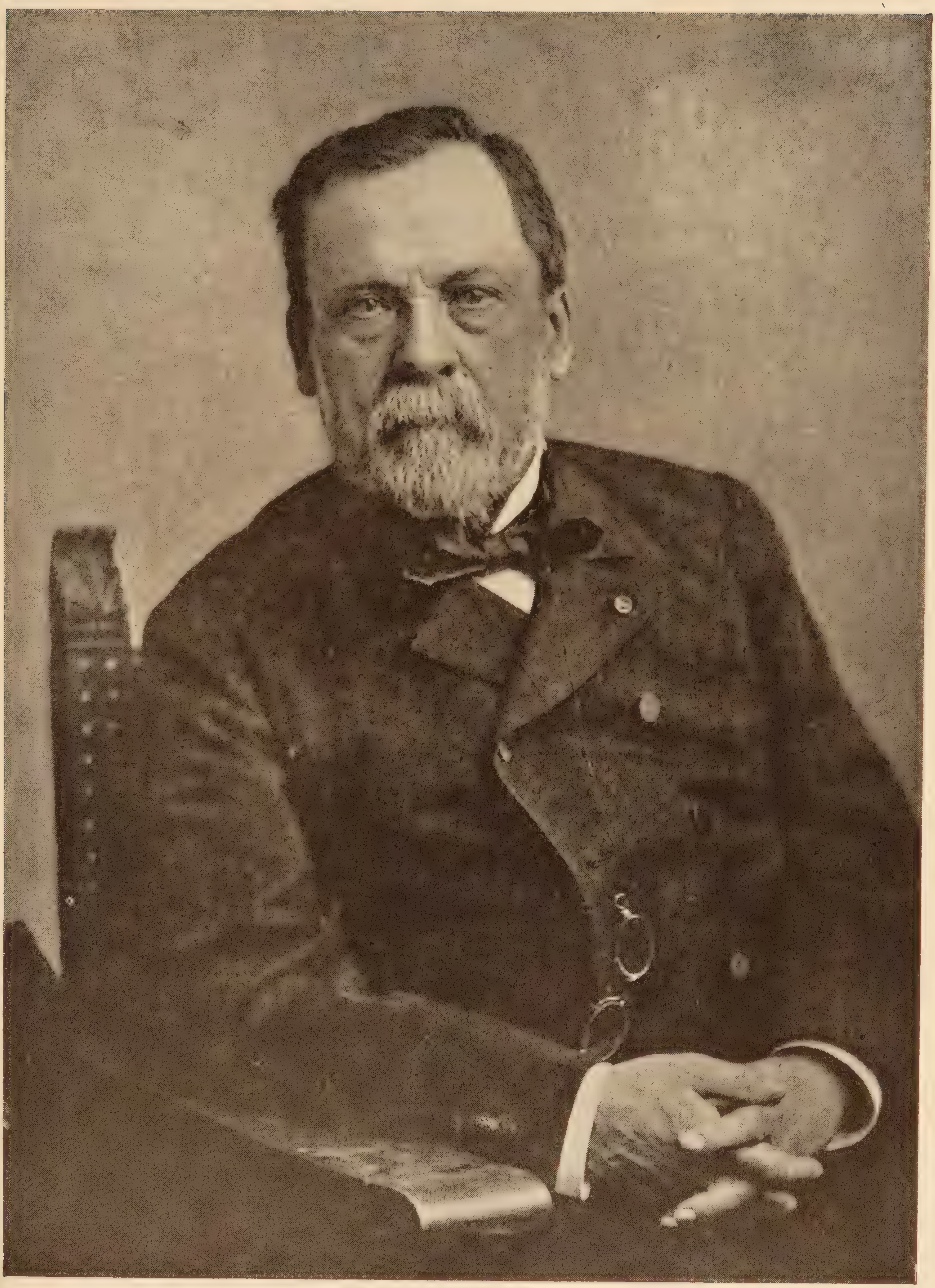


Ne craignez pas de réclamer ce qui vous est dû
avec déférence et respect dans les termes, mais
énergiquement par la logique des faits.

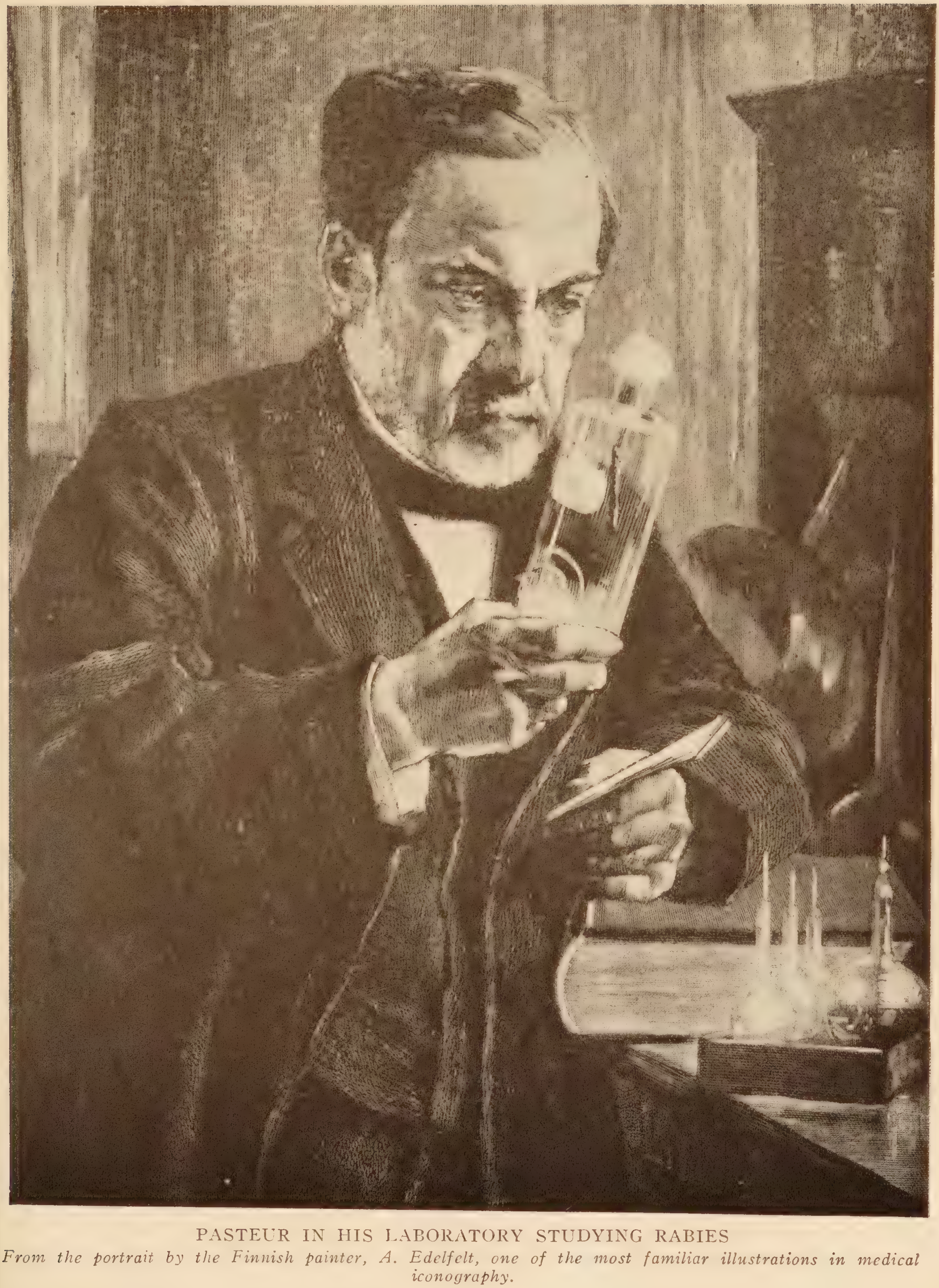
Agréez l'assurance de mes meilleurs sentiments

L. Pasteur

LETTER FROM LOUIS PASTEUR TO PAUL ROBIN

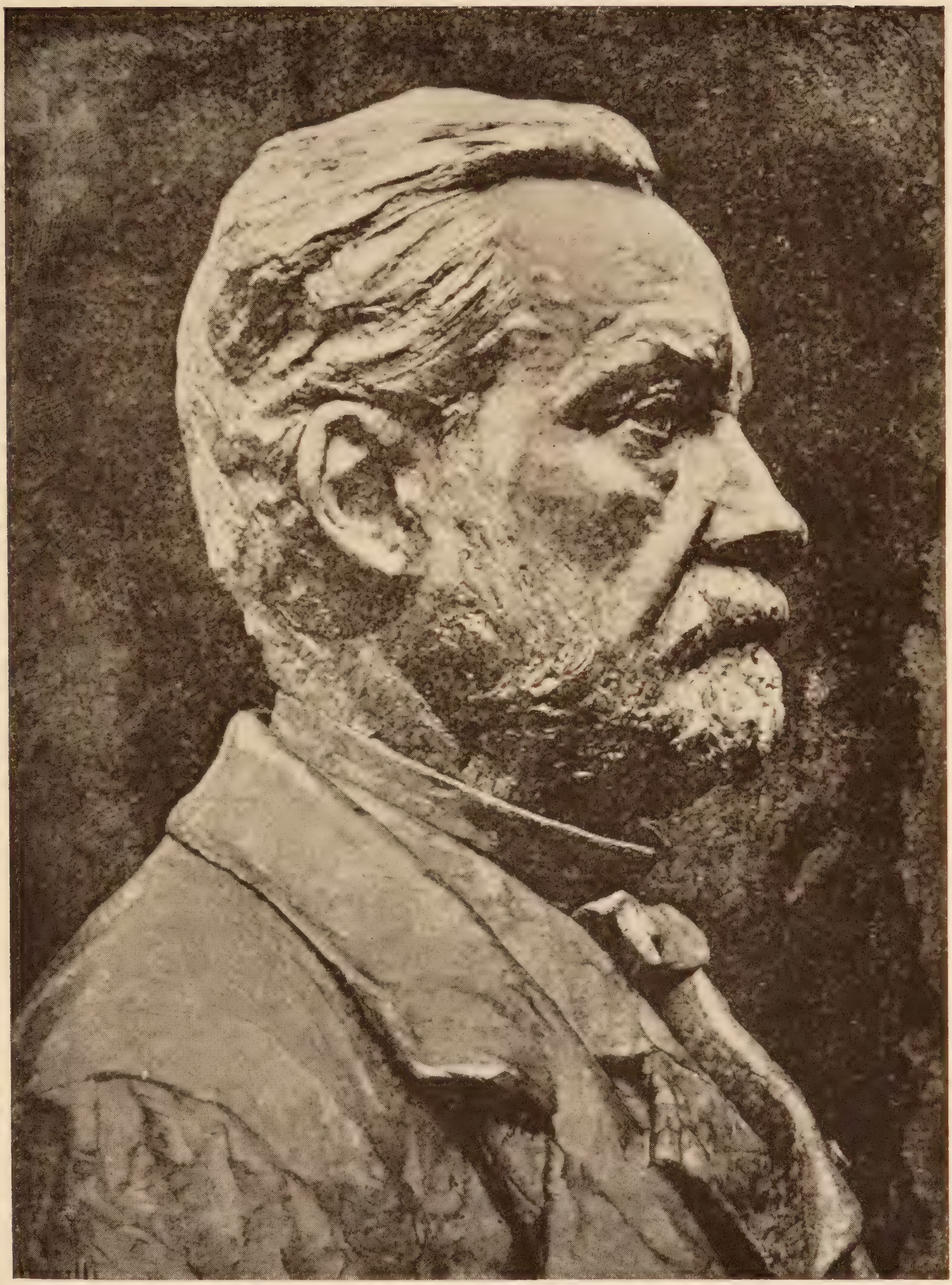


PASTEUR

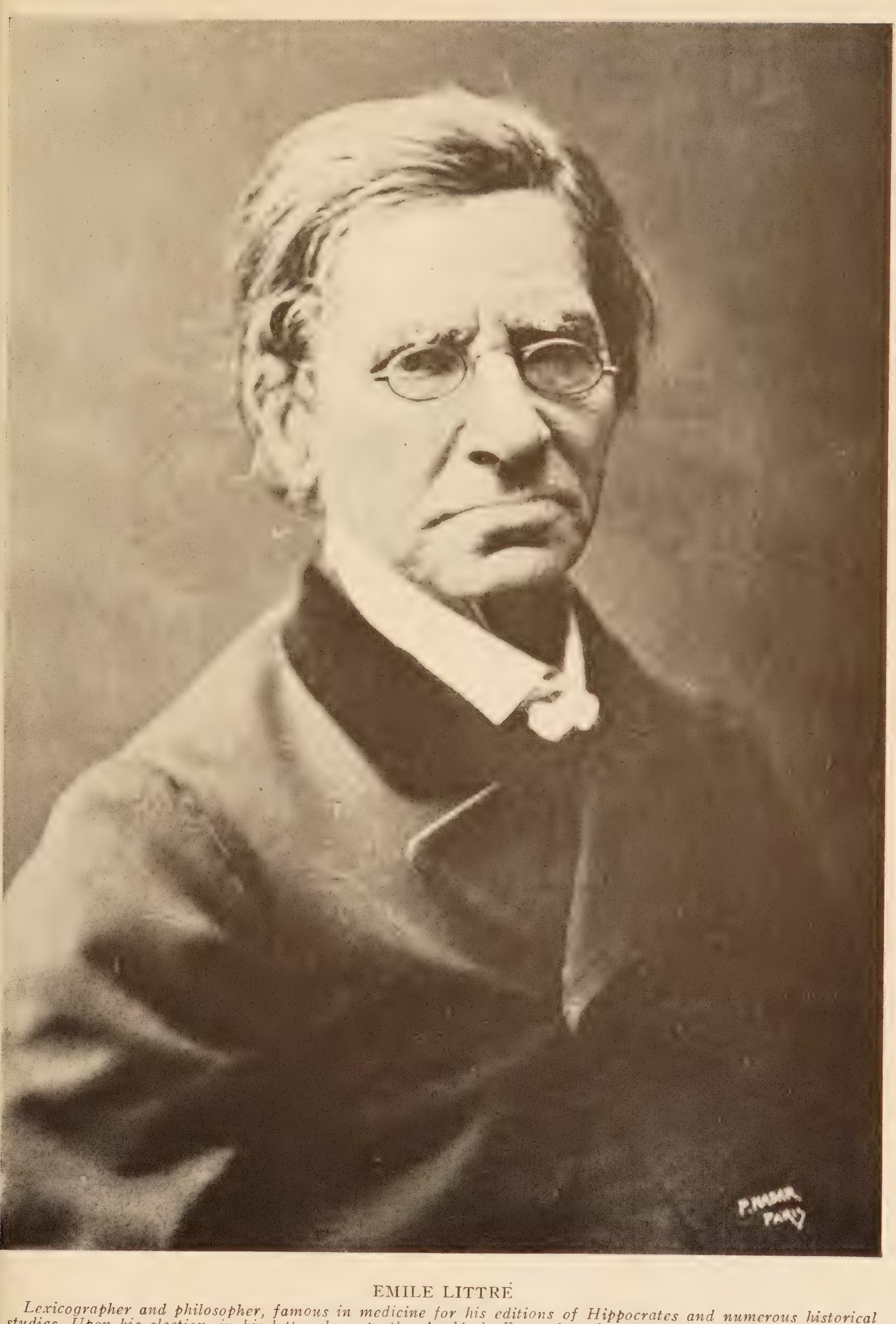


PASTEUR IN HIS LABORATORY STUDYING RABIES

From the portrait by the Finnish painter, A. Edelfelt, one of the most familiar illustrations in medical iconography.



LOUIS PASTEUR
From an Engraving by A. Leveille. After the Bust by Paul Dubois.



EMILE LITTRÉ

Lexicographer and philosopher, famous in medicine for his editions of Hippocrates and numerous historical studies. Upon his election, in his latter days, to the Académie Française, the distinguished Bishop Dupanloup resigned in protest—but when Littré's chair became vacant, he was succeeded by Pasteur who said in his éloge: "Often have I fancied him seated by his wife, as in a picture of early Christian times: he, looking down upon earth, full of compassion for human suffering; she, a fervent Catholic, her eyes raised to heaven: he, inspired by all earthly virtues; she, by every Divine grandeur; uniting in one impulse and in one heart the twofold holiness which forms the aureole of the Man-God, the one proceeding from devotion to humanity, the other emanating from ardent love for the Divinity: she a saint in the canonic sense of the word, he a lay-saint. This last word is not mine; I have gathered it on the lips of all those that knew him."

THE SHEPHERD JUPILLE STRUGGLING WITH THE MAD DOG

THE PASTEUR STATUE AT THE SORBONNE

THE PASTEUR STATUE AT PLACE DE BRETEUIL

Erected by international subscription.

The first direct descendant of Pasteur's germ theory of putrefaction was Lister's antiseptic method in surgery. Before the advent of Listerism, a hospital was the morgue's ante-room where even trifling operations, no matter how skilfully performed, frequently terminated in frightful suppuration, sepsis, and death. The operating-table was as dangerous as the battlefield, and the rivers of pus that flowed through the wards were more terrifying than the blood spilled in carnage. As an enemy, the streptococcus was fully as redoubtable as any cannon-ball.

Lister's system changed all this, thus effecting the most beneficent revolution in surgical annals. In private, on public platforms, and in print, Lord Lister consistently maintained that he had simply taken Pasteur's discoveries and applied them to surgery. It is interesting to recall that in Lister's original communication, which was in 1867, he referred to the French chemist's researches, and in 1874 Lister sent Pasteur a letter which constituted a greater honor than any monarch or government could bestow:

My dear Sir—Allow me to beg your acceptance of a pamphlet, which I send by the same post, containing an account of some investigations into the subject which you have done so much to elucidate, the germ theory of fermentative changes. I flatter myself that you may read with some interest what I have written on the organism which you were the first to describe in your *Mémoire sur la fermentation appelée lactique.*

I do not know whether the records of British surgery ever meet your eye. If so, you will have seen from time to time notices of the antiseptic system which I have been laboring for the last nine years to bring to perfection.

Allow me to take this opportunity to tender you my most cordial thanks for having, by your brilliant researches, demonstrated to me the truth of the germ theory of putrefaction, and thus furnished me with the principle upon which alone the antiseptic system can be carried out. Should you at any time visit Edinburgh, it would, I believe, give you sincere gratification to see at our hospital how largely mankind is being benefited by your labors.

I need hardly add that it would afford me the highest gratification to show you how greatly surgery is indebted to you.

Forgive the freedom with which a common love of science inspires me, etc.

Twenty-five years after the publication of his epoch-making contribution in *The Lancet,* the Father of Antiseptic Surgery came to the Sorbonne to greet the Father of Preventive Medicine at his jubilee. When Lister uttered the words, "You have raised the veil which for centuries had covered infectious diseases; you have discovered and demonstrated their microbian nature," the emotional Pasteur, unable to contain himself, advanced toward the speaker. When these two old men embraced, a new star should have appeared in the heavens to commemorate the event. Only a small percentage of the human race entertains any adequate realization of how much we really owe to the combined labors of Louis Pasteur and Joseph Lister.

In 1883, although still in the flesh, Pasteur was an established classic; thus there was nothing incongruous in the publication of a standard biography of the scientist, by his youthful son-in-law, René Vallery-Radot. In the forty years that have since gone by, the book has several times been revised, reprinted, translated, and is still circulating—a record which can be duplicated by no other biography of a chemist. The book seems to have received only commendation. The first English edition was translated by Lady Claud Hamilton, and prefaced by the great Tyndall. A subsequent edition was translated by Mrs. R. L. Devonshire, with an introduction by Osler, who said he had read the work three or four times. Stephen Paget evidently pronounced the consensus of opinion when he declared it was "one of the best of all books, and ought to be in every public library. I have borrowed much from it; and I hope that my little book may be regarded as a sort of signpost on the way toward the well-beloved *Vie de Pasteur.*"

Into this chorus of praise, we regret we must interject a disharmonious note. It is of course true, as L. Descour states, that Vallery-Radot's book is "a work of the greatest documentary value." As the man who married Pasteur's only surviving daughter, Vallery-Radot had access to certain letters and information not elsewhere obtainable. His quotations are admirable, his interpolations often lamentable. He knew intimately the history of Pasteur, but caring little about strangers, he underrated their value in the development of science. It is true that Koch erred in attacking Pasteur's theory and method of attenuation, but if we accept Vallery-Radot's viewpoint, then we must believe that Robert Koch knew nothing about anthrax, and that his chief function as a bacteriologist was to commit blunders for Pasteur's correction. The eminent discoverer of the diphtheria bacillus is referred to as "a German of the name of Klebs." According to Vallery-Radot, the cause and cure of puerperal sepsis is exclusively a French discovery—there is not a syllable about the prior labors of the martyred Semmelweis! Through every chapter there breathes an ill-concealed contempt for all the precursors of Pasteur. Thus side by side with Pasteur's lofty elevation, runs the muddy stream of his son-in-law's baser spirit. Conceived in bias, and brought forth in chauvinism, "one of the best of all books" must be read with extreme caution.

To those, however, whose general knowledge of scientific history enables them to discount Vallery-Radot's unfairness, his book is invaluable for its personal touches. For example, the first edition—*M. Pasteur, Histoire d'un Savant par un Ignorant*—concludes with a graphic picture well-worth reproducing:

> Even now the experiments are in full swing. Biting dogs and bitten dogs fill the laboratory. . . . There never occurs a case of hydrophobia in Paris of which Pasteur is not informed. Not long ago a veterinary surgeon telegraphed to him, "Attack at its height in poodle-dog and bull-dog. Come." Pasteur invited me to accompany him, and we started. . . . The bull-dog especially, an enormous creature, howled and foamed in its cage. A bar of iron was held out to him: he threw himself upon it, and there was great difficulty in drawing it away from his bloody fangs. . . .

> Two youths then threw a cord with a slip loop over the dog, as a lasso is thrown. The animal was caught and drawn to the edge of the cage. There they managed to get hold of him and to secure his jaws; and the dog, suffocating with fury, his eyes bloodshot, and his body convulsed with a violent spasm, was extended upon a table and held motionless, while Pasteur, leaning over his foaming head, at the distance of a finger's length, sucked up into a narrow tube some drops of the saliva. In the basement of the veterinary surgeon's house, witnessing this formidable tête-à-tête, I thought Pasteur grander than I had ever thought him before.

Had Pasteur's life ended with this passage, he would still be ranked among the foremost in world-history, but he would have missed the greatest adventure of his career. Glorious as was Pasteur's youth, illustrious as was his middle-life, it was nevertheless reserved for his old age to climb an even higher mountain-peak. In regard to these experiments in rabies, Mme. Pasteur wrote to her children: "Your father is absorbed in his thoughts, talks little, sleeps little, rises at dawn, and, in one word, continues the life I began with him this day thirty-five years ago."

Word was spreading in all directions that another horror might soon be removed from the earth, for Pasteur hoped to vanquish the dreaded hydrophobia. Peasants and emperors now watched Pasteur's laboratory with interest. In answer to an inquiry from the Emperor of Brazil, Pasteur replied: "I already have several examples of dogs made refractory after a rabietic bite. I take two dogs, cause them both to be bitten by a mad dog; I vaccinate the one and leave the other without any treatment: the latter dies and the first remains perfectly well."

Later he wrote to Jules Vercel of Arbois—the same Jules Vercel with whom, almost half a century previous, he had first set out for Paris:

> Alas! we shall not be able to go to Arbois for Easter; I shall be busy for some time settling down, or rather settling my dogs down at Villeneuve l'Etang. I have also some new experiments on rabies

> on hand which will take some months. I am demonstrating this year that dogs can be vaccinated, or made refractory to rabies *after* they have been bitten by mad dogs.
>
> I have not yet dared to treat human beings after bites from rabid dogs; but the time is not far off, and I am much inclined to begin by myself—inoculating myself with rabies, and then arresting the consequences; for I am beginning to feel very sure of my results.

While the scientist thus wrestled with his doubt, an agonized mother from Alsace entered his laboratory. She brought to Pasteur, her little son, Joseph Meister. Walking unguarded to school along a country road, the helpless child had been pounced upon by a mad dog, who bore him to the ground and wounded him fourteen times. He would have been killed on the spot, had not a bricklayer finally succeeded in driving the animal off. That nameless bricklayer deserves a monument: he not only saved a child, but he hastened the proof of the Experimental Method!

Joseph Meister was nine years of age. What memories must have awoke in Pasteur! He too was just nine years of age, when standing by his father's tannery he had seen a bitten person seared by the blacksmith's iron. For that ancient ordeal, so terrible and so inadequate, Pasteur now substituted a little rabic marrow in a Pravaz syringe.

As the rabic medulla increased in virulence, Pasteur shuddered at the inoculations. When the patient was injected with marrow of such strength that it produced hydrophobia in unprotected animals within a week, Pasteur could no longer sleep. We love this man for his insomnia. Ghosts haunted him throughout an appalling night that would not end: he saw the look of alarm on the child's face, he saw him in vain try to swallow, he heard the paroxysms of choking as the boy perished from the cruelest malady known to medicine. Would dawn never come again? In the morning, Pasteur was a sick man. Taking his daughter with him, he left his laboratory and fled to the country, leaving little Meister in the care of one of his disciples, J. J. Grancher. Pasteur attempted to rest in Burgundy, and then at Arbois, yet was ever tortured by the conviction that a telegram would come from Dr. Grancher announcing the death of the first patient treated by inoculation.

But with a pin-prick, the genius of Pasteur had established immunity. Not only did Meister remain in perfect health, but he imagined himself in the best of luck, for he soon made pets of Pasteur's rabbits, chickens, white mice and guinea-pigs. More than one of these animals, predestined for laboratory purposes, was saved by the pleadings of Master Joseph. After Meister's return to his native Alsace, the blue-eyed lad frequently received letters that were postmarked Paris. About a year later, when funds were being raised to establish a hydrophobic service, Pasteur, while looking over the list of subscribers, was happy to find the name of Joseph Meister.

Upon Pasteur's election, a few years before this, as One of the Forty, he had been welcomed in a remarkable address by the author of *Averroes;* not content with enumerating, in bewitching language, Pasteur's actual accomplishments, Renan had played with prophecy: "Humanity will owe to you deliverance from a horrible disease and also from a sad anomaly: I mean the distrust which we cannot help mingling with the caresses of the animal in whom we see most of Nature's smiling benevolence." Ernest Renan lived to see the truth of his augury.

Pasteur's second case of hydrophobia was fully as interesting as the first. Six shepherd boys, from Villers-Farlay in the Jura, were tending their flock, when an enormous dog, lashing his jaws with fury, charged upon them. The children rose in fear, and it was pathetic to watch their attempt to fly with trembling limbs before a swift-moving terror that gained every moment upon them. Only the eldest of the group did not run. Whip in hand, Jean Baptiste Jupille, fourteen years of age, met the mad animal. In the struggle that followed, the whip fell to the ground. With bleeding hands, the shepherd took off one of his wooden shoes and began to beat the animal upon the head. Chance moved back and forth over the meadow that autumn morning. At length death overtook the mad creature, but his mark was likewise on Jupille, covered with rabid blood and saliva. Only from Pasteur could the young hero hope for life.

Meister had been brought to the laboratory in less than three days after his accident, but six full days elapsed before Jupille received his initial injection of the mitigated virus. Pasteur complimented the boy on his courage, and found that Jupille was embarrassed at being praised. At the Academy of Sciences, Pasteur, after explaining the technique of his treatment, could not refrain from extolling Jupille's deed of self-sacrifice. Baron Larrey, usually the most impassive of men, thereupon arose, and proposed that the Académie Française bestow upon Jupille the Montyon Prize. The young shepherd from Villers-Farlay became a French sensation.

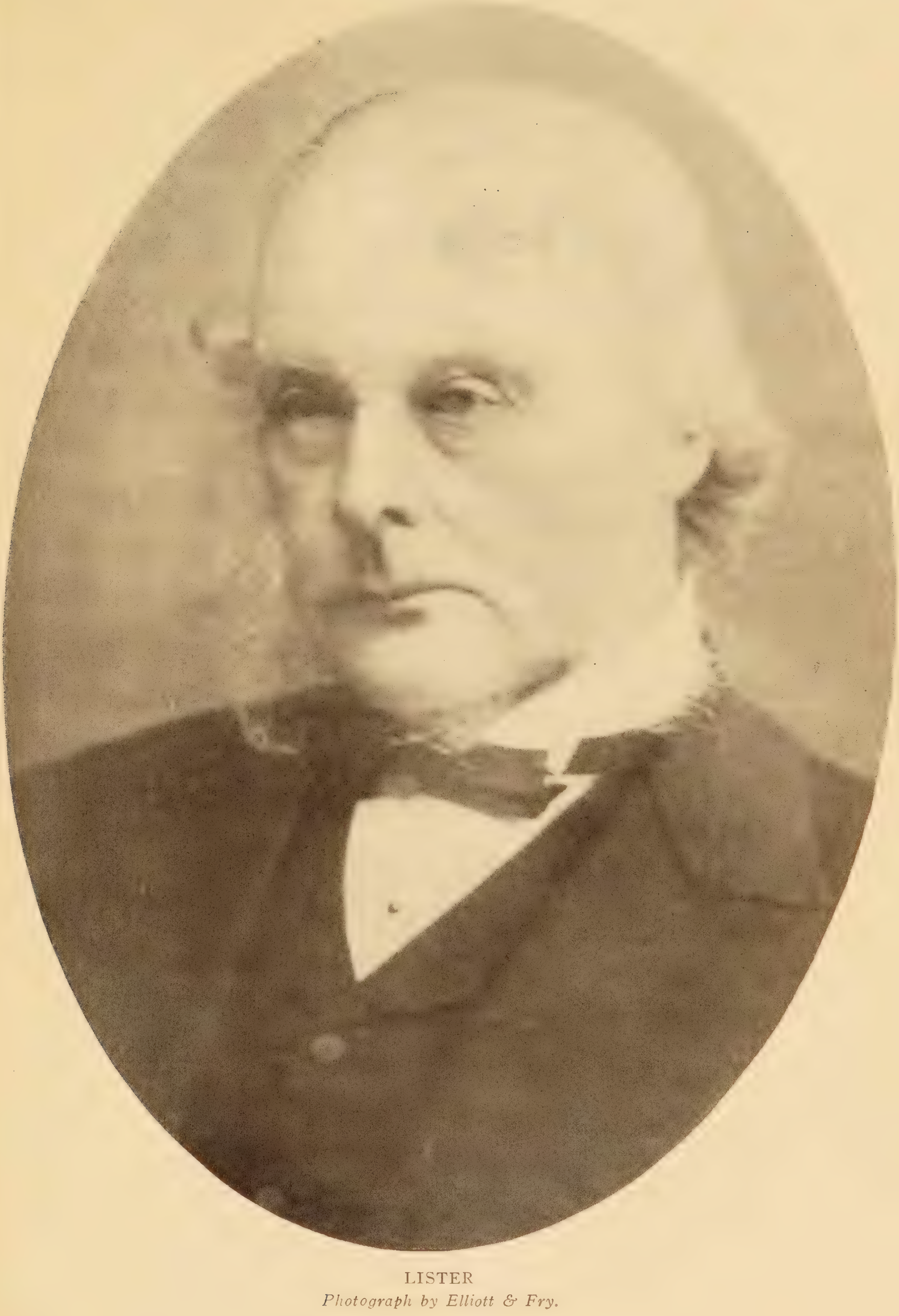
Afterwards, Pasteur corresponded with Jupille, and sometimes complained of the hero's orthography. The following extract exhibits Pasteur as a volunteer supervisor of education: "Your writing is already much better than it was, but you should take some pains with your spelling. Where do you go to school? Who teaches you? Do you work at home as much as you might? You know that Joseph Meister, who was first to be vaccinated, often writes to me; well, I think he is improving more quickly than you are, though he is only ten years old. So, mind you take pains, do not waste your time with other boys, and listen to the advice of your teachers, and of your father and mother."

It may be added that the brave Jupille never developed into a savant, but he drank deeply of the cup of fame. When the Pasteur Institute was erected for the prophylaxis of rabies, a statue of Jupille, battling with the mad dog, was placed in the courtyard. The caretaker of the great building was no other than Joseph Meister himself. He looked splendid in his uniform and mustache, with a medal on his breast, and to him was vouchsafed the unusual felicity of being able to pose against his successor's statue.

Statistics quickly accumulated in favor of preventive inoculation. Every case that was not already hopeless, found life and health in Pasteur's sterilized flasks. Against his judgment, and knowing it would jeopardize his method, but unable to resist the entreaties of her parents, and overcome with pity for the victim, Pasteur consented to receive for treatment little Louise Pelletier, thirty-seven days after she had been bitten on the head by a mad mountain-dog. Much affection developed between Pasteur and the patient. He gave her a double series of inoculations, and for a brief time a ray of hope warmed his heart, but it was too late to prevent convulsive spasms. The great laboratory was neglected; Pasteur spent an entire day at the child's bedside. Louise Pelletier died holding the hand of Louis Pasteur. He burst into tears, and his opponents, led by M. Peter, burst into triumphant denunciations of all things Pasteurian. A few other failures, inevitable from the outset—and every one of which caused him the deepest suffering—brought upon him an avalanche of anonymous abuse. Pasteur had discovered the method of preventing hydrophobia of the body—he did not possess a vaccine against rabies of the soul.

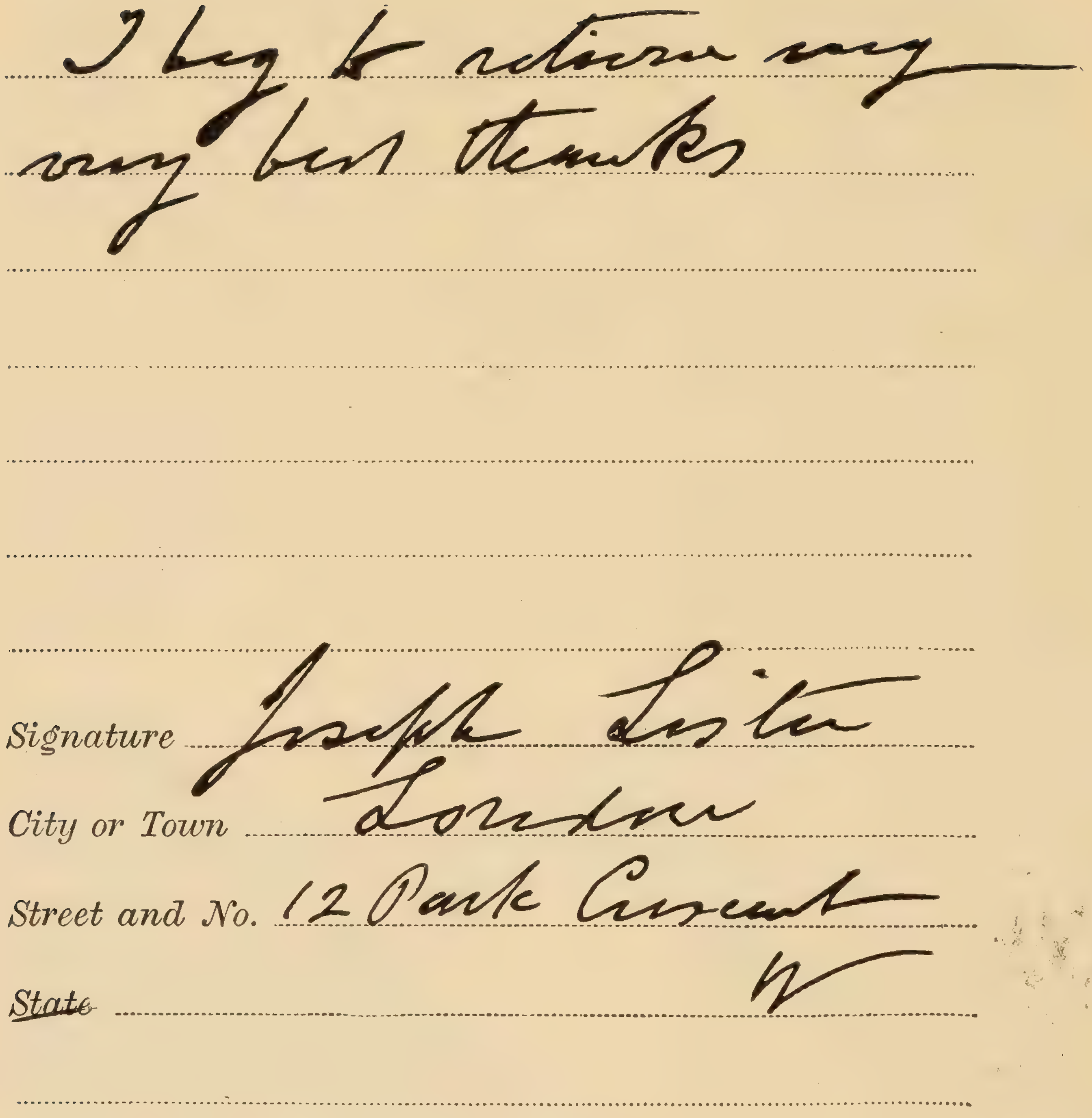
In spite of the Peters in the Academy of Medicine, in spite of the attacks in the newspapers, all nations made a path to Pasteur's door. Nineteen Russian peasants from the distant province of Smolensk, badly mangled by a raving wolf, some of them torn beyond recognition, began the journey to seek the talisman that hung by a thread in the mysterious flasks. The journey was regarded as their last. Yet sixteen of them returned with laughter to Smolensk. Their restoration was looked upon as a resurrection. The Tsar presented Pasteur a decoration of diamonds, and sent a substantial contribution to his institute.

Through the enterprise of the New York Herald—which is enterprising no longer—four American children, recently bitten by rabid dogs, were sent to be cured by the kindly wizard. The children were surprised that the long journey should culminate in a few jabs which they hardly felt. They did not understand



LISTER

Photograph by Elliott & Fry.



I beg to return my very best thanks

Signature Joseph Lister

City or Town London

Street and No. 12 Park Crescent

~~State~~ W

HANDWRITING OF LISTER

In connection with Index-Catalogue of the Library of the Surgeon-General's Office, U.S. Army, Washington, D.C. Received at Surgeon-General's Office, December 23, 1895.

that behind each pin-prick was one of the greatest minds that ever blessed the human race. Instead of succumbing in agony and exhaustion, instead of being abandoned by terror-stricken parents, or being smothered between two mattresses as was frequently the fate of hydrophobic children in the pre-pasteurian era, these youngsters came back to their families in the best of condition.

Time has passed, and it is no longer necessary to cross mountains and seas to reach a Pasteur Institute. That mother institute in Paris has offspring, not only throughout Europe and the Americas, but in Tunis, Indo-China, Morocco, and Cambodia.

The homage which was Pasteur's in his later years, never corrupted the goodness of the man. He was too loving to be spoiled by the trumpets of fame. To the end of his life he spent his vacations in the very tannery where he had grown up, and which he had once left with so much foreboding, and to which he had been brought back by his father. The name of Pasteur reached to every corner of the earth, but Arbois always remained his home. The martial tread of General Baron Delort was no longer heard on the bridge above, and Arbois was now dependent for its reputation upon the civilian who sat in the garden below. Yet a stranger who glanced casually at the crippled, sickly-looking undersized old man resting quietly under his yellowish quinces, or talking gently to any passing child, might not have realized that before him he beheld the most famous Frenchman since Napoleon Bonaparte.

The death-bed of Louis Pasteur was in keeping with the sanctity of his life. Gazing with infinite tenderness at his old wife and family and grandchildren, surrounded by his disciples, to whom he murmured, "There is still a great deal to do!" Louis Pasteur passed away.

How could his disciples bear to leave such a man? They could not; and taking the body of their master, they buried him in the Pasteur Institute, and over the arches of his mausoleum they inscribed the names and dates of his immortal discoveries. Working in the laboratory, his students thus worship at the shrine of Pasteur:

No cypress-shadowed churchyard, nor the gloom
Of haunted cloisters, doth immortalize
The dust of him whose patience proved more wise
To save than Death to slay. The busy loom
Glancing with silk, the teeming herd, the bloom
Of purpling vineyards, and the grateful eyes
Of souls reprieved at Death's most dread assize,
Shall make eternal gladness round his tomb.
Not 'mid the dead shall he be laid asleep
Who wageth still with Death triumphant strife,
Who sowed the good that centuries shall reap,
And took its terror from the healer's knife;
Defender of the living, he shall keep
His slumber in the arsenal of life.

(1843–1910)

ROBERT KOCH

The investigations which he had previously made upon anthrax and experimental traumatic infections, by perfecting the methods of research, paved the way for this brilliant discovery of the bacillus tuberculosis. His preliminary article and his more elaborate work should be carefully studied by any one who wishes to appreciate the value of scientific methods. It forms one of the most masterly demonstrations of modern medicine. Its thoroughness appears in the fact that in the nine years which have elapsed since its announcement the innumerable workers in the subject have not, so far as I know, added a solitary essential fact to those presented by Koch.

Osler (1894).

Asiatic Cholera: This terrible plague, even in the middle of the nineteenth century, swept away thousands of lives in America; now it has been so thoroughly controlled that it is not feared even to the extent of disturbing commerce when it appears. It originated on the banks of the Ganges in India, where Koch found its spirillum and the means of its spread.

Osler (1919).

In 1876 there appeared in Cohn's "Beiträge zur Morphologie der Pflanzen," a paper on the Etiology of Anthrax, by a German district physician in Wollstein, Robert Koch, which is memorable in our literature as the starting point of a new method of research into the causation of infectious diseases. . . . Koch is really our medical Galileo, who by means of a new technique,—pure cultures and isolated staining,—introduced us to a new world. In 1878, followed his study on the Etiology of Wound Infections, in which he was able to demonstrate conclusively the association of micro-organisms with the disease. Upon these two memorable researches made by a country doctor rests the modern science of bacteriology.

Osler (1921).

XXVIII

ROBERT KOCH

I. HIS LIFE

Night in Wollstein, with distant hoof-beats violating the darkness. The rhythmic trot-trot of the horse and the roll of carriage-wheels alone break the silence. Within the recesses of a cumbrous rig, is seated the kreisphysicus. Disease is sleepless, and over the rough roads the young doctor has traveled many nights for many miles. In that mysterious interlude between moonset and dawn, he has raced often with death. Driving home in the darkness, at times victorious and at times defeated, the shadows of his childhood come out and ride with him.

His father, the expert mining engineer, nearly always away at the mines; his mother, who opened the gates of life to thirteen children, attending to unending tasks, and yet finding time to direct the family education and keep a diary. The wild days of boyhood in the family-orchard at Klausthal: adults absent, and girls contemptuously relegated to the background; secret whispering followed by excited voices, and terrible battles alternating with passionate vows of comradery.

They possessed the boys' traditional love for dogs, but swore a bloody revenge against all cats. Claiming that cats caught poultry, they set cat-traps in the bushes and in the course of time counted a dozen victims. The trapped cat was placed in a sack, tied fast, and then its head was forced into a corner of the bag, a rope was thrown around it and the animal was strangulated. Once they boiled the cat, and tasted some of the meat, these young connoisseurs pronouncing it similar to a hare. Frogs' legs were broiled in the field and consumed unskinned, and potatoes would then be baked in the burning ashes. Their taste for broiled grasshoppers was inspired by their biblical knowledge.

These outdoor meals, which were apt to be haphazard, were supplemented by more legitimate food: black bread and fresh milk in the morning, legumes and milksoup at midday, black bread and butter or stale bread and apples in the afternoon, bread and butter with cheese, or bread with sweet milk or buttermilk in the evening. White bread was reserved for Sunday morning, meat made its appearance only twice a week, and sugar and coffee and tea were delicacies known only by reputation.

Clothing: during the summer and throughout the autumn they wore blue linen jackets and linen pants; in mid-winter the latter were replaced by cloth-pants, and as the younger inherited the apparel of their elders, and as the patches of the passing years were of various designs and colors, the final result was sometimes quaint. Happy days, when poverty and youth and struggle and hope sat at their table!

Reliving those days again, the young doctor remembered the hedges he had scaled and the trees he had climbed. In these escapades, not only were pantaloons damaged, but limbs were endangered. Involuntarily he twitched the arm which he had broken in one of his arboreal adventures, and which a mountain surgeon had skilfully set. What a collector he had been in those days, wandering over the Upper Harz Mountains with a copy of Leuni's Natural History, a bottle of alcohol, pins and boxes for insects. It was he who had skinned the captured cats, and attempted to mount a skeleton of Felix domestica. He kept also an aquarium and herbarium.

Memories of the Klausthaler Gymnasium: the miserable instruction; the doddering old director, constantly siding with the pupils against the teachers, and thus destroying all discipline; the teachers who attempted to chastise unruly students, but were themselves tripped up and severely beaten by the big pupils; the funeral oration preached over a teacher who entered the crêpe-draped room in the midst of his own obituaries; athletics; the Concordia Club, where he sang very badly.

His father's determination that he should learn the shoemaker's trade, since there was not sufficient money to send him to the University; the improvement in the family circumstances which rendered possible his academic career; that unforgettable Easter of 1862, when at the age of nineteen he entered the University of Göttingen as a student of medicine; the bottle of ink which opened and spoiled his laundry; first glimpse of famous scientists; his enthusiasm for investigation; his prize essay, on the occurrence of ganglion cells in the nerves of the uterus, dedicated to his father; his work on the origin of succinic acid in the human organism, with self-experimentation that produced a violent gastric catarrh; Henle's never-forgotten dictum: "Before microscopic forms can be regarded as the cause of contagion in man they must be found constantly in the contagious material, they must be isolated from it and their strength tested."

Graduation. Contact with teachers ended. Academic moorings swept away. General practice in the little town of Rachwiz. Service in the Franco-Prussian war. Resumption of practice in Wollstein, in the province of Posen, the most benighted region of Germany, more Polish than German. The letter to Ferdinand Cohn—would it be ignored?

The darkness of the Wollstein nights engulfed the young doctor, but he rode on and was not lost. He crossed boundaries deemed impassable, and traveling over new roads, reached outposts hitherto unknown. To his discoveries he signed the name of Robert Koch, and in medical annals there is no greater name.

In 1876, Robert Koch was in his thirty-third year, and had worn the doctor's cap for a decade. In these ten years, numerous reputations had been made in medicine, but it seemed as if Koch the investigator would be swamped by Koch the kreisphysicus—Göttingen is far from Wollstein. Koch, however, had brought his microscope with him, and when he looked through the ocular an unseen institute of research arose in the province of Posen. In the spring of this year he dispatched to Cohn the following letter:

> Esteemed Herr Professor: Stimulated by your work on bacteria published in Contributions to Biology of Plants, I have, for some time, been at work on investigations of Anthrax Contagium, as I was able to secure the necessary material. After many vain attempts, I have finally been successful in discovering the process of development of the bacillus anthracis. After many experiments, I believe to be able to state the result of these researches with sufficient certainty. Before, however, I bring this into the open, I respectfully appeal to you, esteemed Herr Professor, as the foremost authority on bacteria, to give me your judgment regarding this discovery. Unfortunately I am unable to prove this by means of preparations containing the individual stages of development, as the attempt to conserve the bacteria in the respective fluids has failed. I would, therefore, respectfully request you to permit me to show you, within the next few days, in the Botanical Institute, the essential experiments. Should you, highly esteemed Herr Professor, be willing to grant my humble request, will you kindly appoint the time when I may come to Breslau.
>
> With the highest esteem, Yours respectfully,
>
> R. Koch, Kreisphysicus.

It must be admitted that Professor Cohn was not thrilled at the sight of Koch's communication. He had received too many letters whose similar claims were not followed by proof. More than one man had entered Cohn's institute, confidently carrying a beautiful hypothesis with him, only to depart with his theory battered beyond repair. Cohn answered Koch as he had answered the others, and a traveler from Wollstein arrived in Breslau. In the history of science no time is more surcharged with dramatic intensity than the moment in which a young investigator, aflame with enthusiasm over his first discovery, confronts a leader of the old generation.

Koch felt if he could earn Cohn's approval, his researches

CONRAD KOCH
Grandfather of Robert Koch.

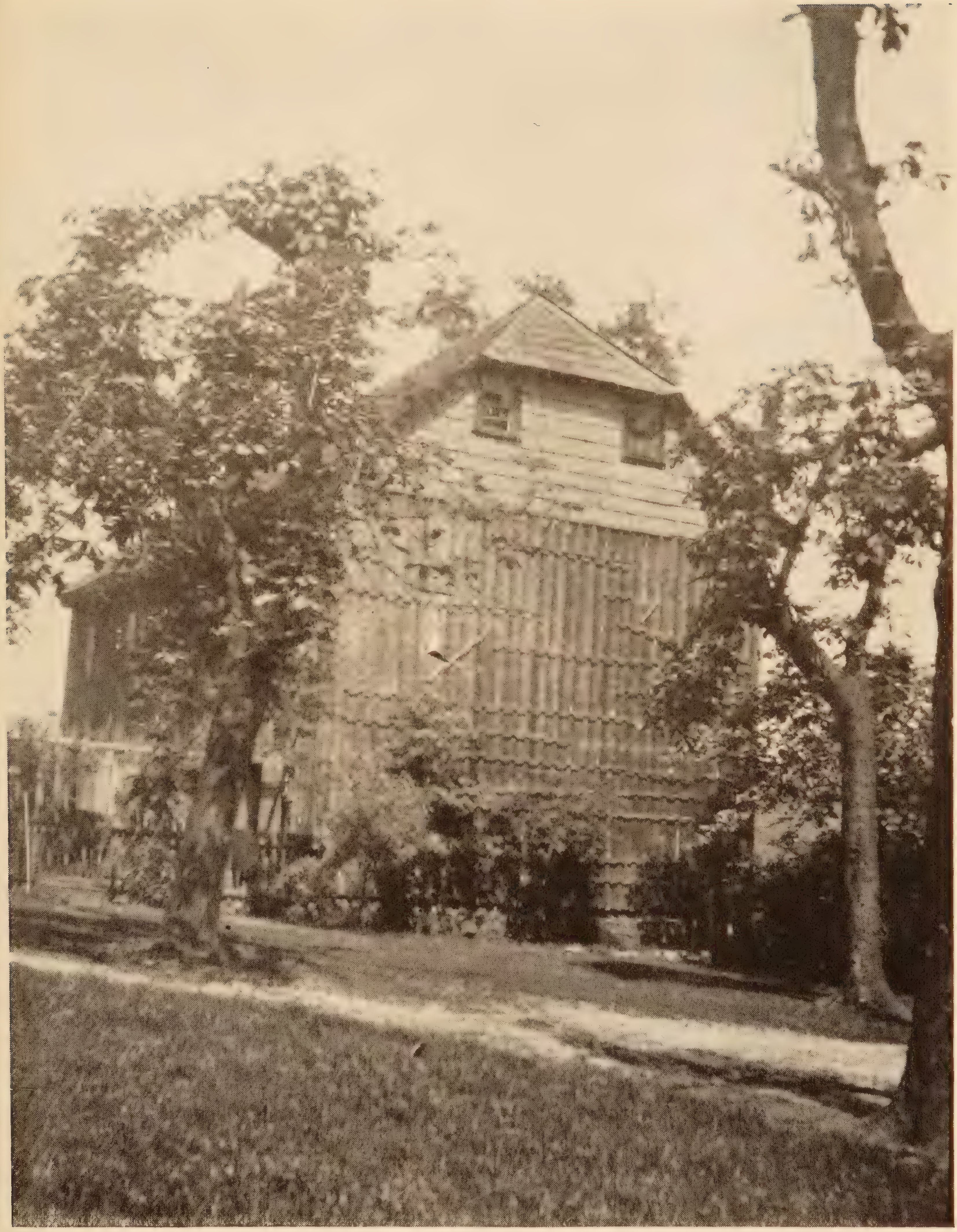
HERMANN KOCH
Father of Robert Koch.

MATHILDE KOCH

Mother of Robert Koch. The niece of Robert Koch, who has placed these family portraits at our disposal, is likewise named Mathilde Koch.

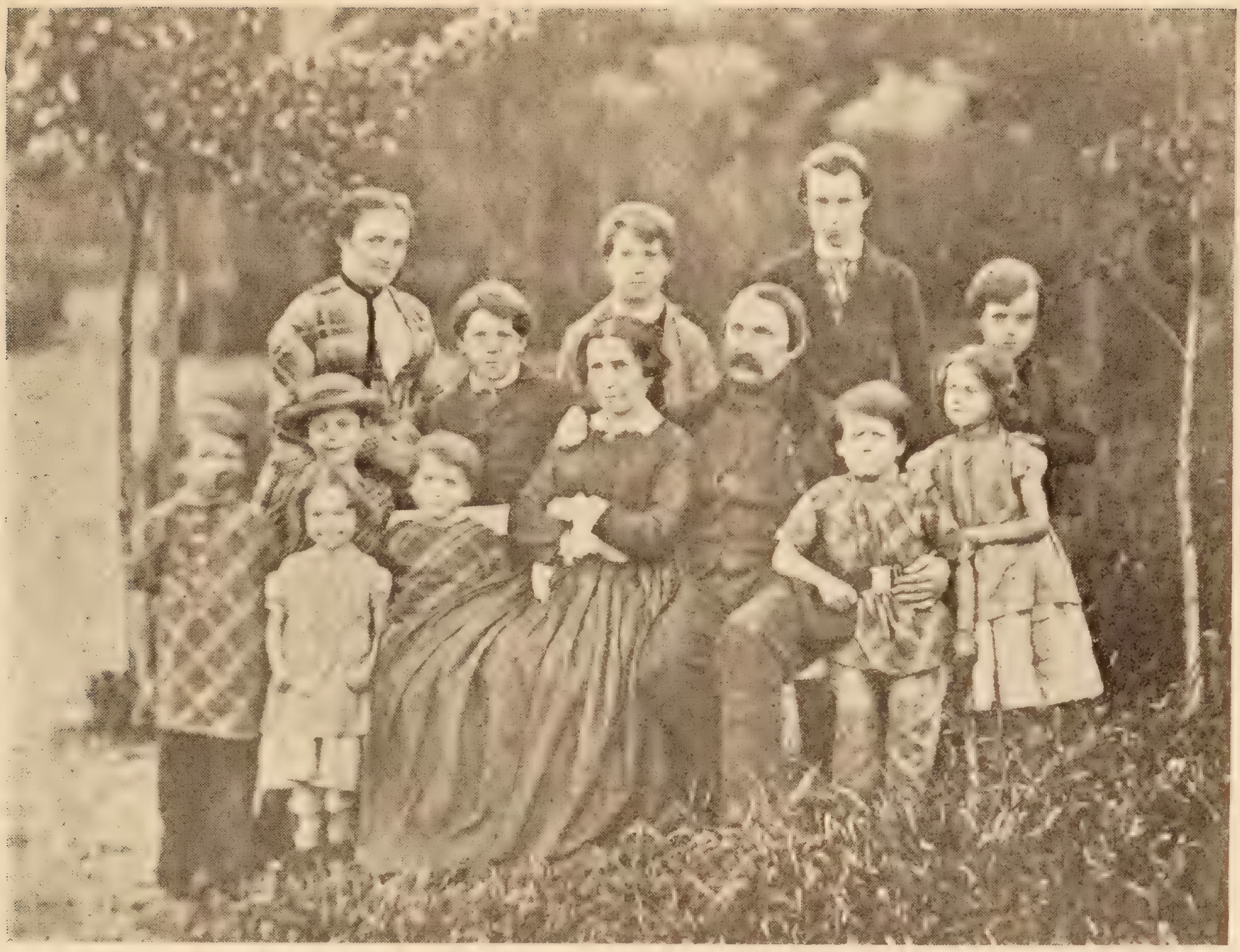
CHURCH AT KLAUSTHAL
Where Robert Koch was confirmed.

THE KOCH HOME AT KLAUSTHAL



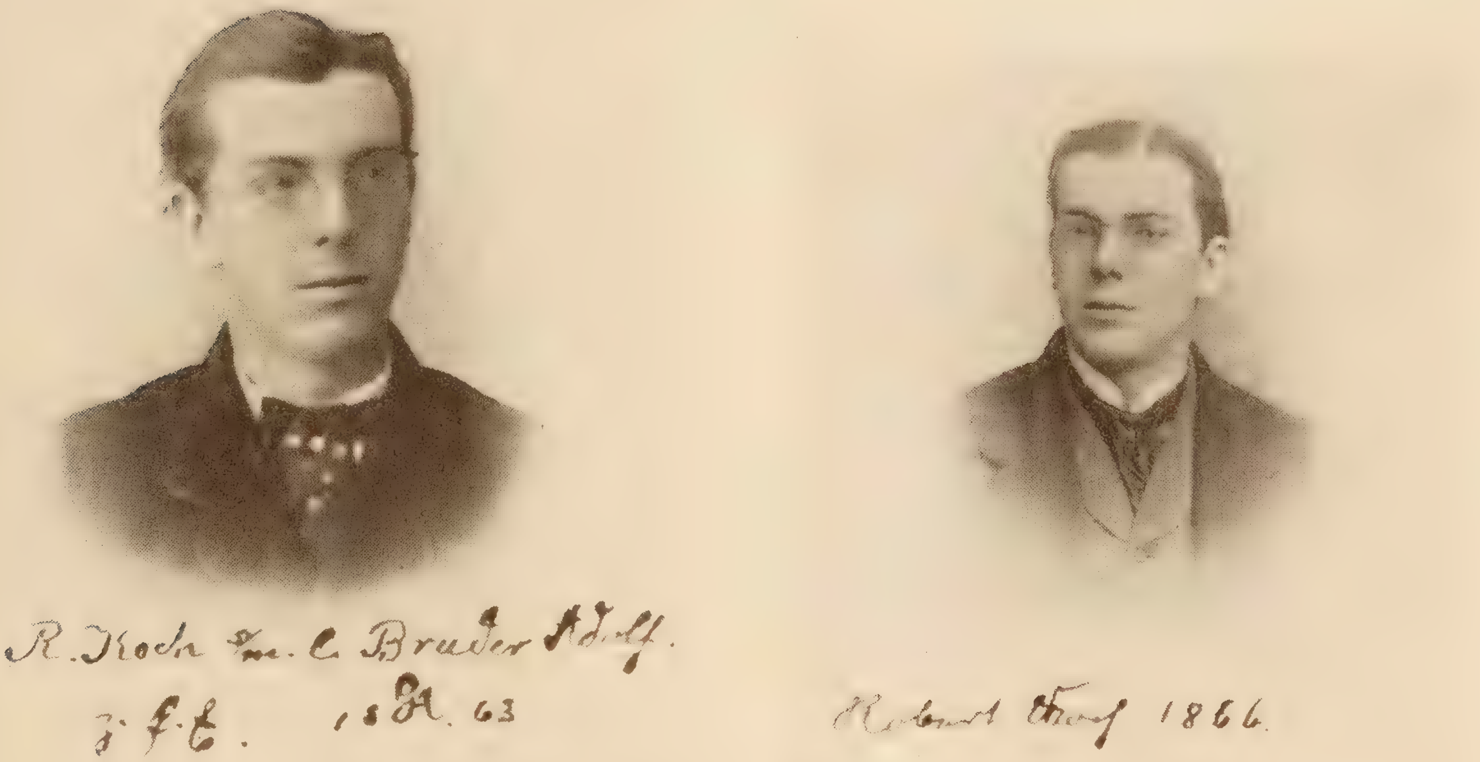
THE BARN AT KLAUSTHAL

Where Robert Koch performed his earliest dissections and experiments.



THE KOCH FAMILY

The little boy with his hair parted more or less in the middle, and his left hand on his mother's shoulder, is Robert.


R. Koch s. m. l. Bruder Adolf.
z. f. E. 18 A. 63
Robert Koch 1866.

ROBERT KOCH AS A STUDENT

Photographs taken in 1863 and 1866.

FERDINAND COHN

(*Above*)
EMMY FRATZ
First Wife of Robert Koch.

(*Below*)
ROBERT KOCH AND HIS ASSISTANTS
in the Cholera Expedition of 1883.

would be laurel-crowned. Cohn was willing to be convinced, but in his eyes the challenger read these questions: Young man, how can you explain that the injection of bacteria-free anthrax blood will infect animals so that their blood will show the bacilli? How can you explain the breaking out of anthrax in regions where the existence of living anthrax bacilli can be excluded? Koch, who had solved the riddle of the bacillus anthracis by the discovery of its spores, answered every objection, not by rhetoric, but by demonstration. Step by step, he proved what he had set out to prove: first, that anthrax bacilli multiply with exceeding rapidity in the blood and tissue juices of the living animal; second, that in the blood of the dead animal or in other suitable nutritive media, the bacilli grow within certain temperature limits and with the admixture of air into long non-branching Leptothrix-like threads with the formation of numerous spores; third, that the spores assume their original form of bacilli in the blood under definite conditions of temperature, nutritive medium and admixture of air. Professor Cohn, founder of bacteriology, for the first time saw unrolled before him the complete life-history and sporulation of a bacterium. Around him were scientific colleagues like Carl Weigert, Moritz Traube, Ludwig Lichtheim, and Leopold Auerbach, whom Cohn had called to witness the new method. A tyro, from the wilds of Wollstein, taught the teachers.

Cohn likewise sent a messenger to Cohnheim's institute, suggesting it would be worth while for one of the pathologists to be present. Julius Cohnheim came himself, and his excitement was literally boundless. Returning to his institute, he admonished his assistants: "Drop everything and go at once to Koch. This man has made a splendid discovery which is all the more astonishing because Koch has had no scientific connections and has worked entirely on his own initiative and has produced something absolutely complete. There is nothing more to be done. I consider this the greatest discovery in the field of bacteriology and believe that Koch will again astonish and shame us with still further discoveries."

Cohnheim was not forced to wait to find himself a prophet, for the next year Koch described his procedures for the examination, preservation and photography of bacteria.

One year later, Koch published his investigations into the etiology of traumatic infective diseases, in which he demonstrated the relationship between microörganisms and infection. Thus Koch, at thirty-five, was a country doctor and a first-class scientific investigator. His friends, especially Cohn and Cohnheim, realizing the incongruity of this combination, managed to have Koch transferred to Breslau as circuit physician. Cohn and Cohnheim, magnificent in science, were weak in political economy, and failed to comprehend that the salary which sufficed for Koch's growing family in the country, was insufficient for their support in the city. Koch soon thought longingly of his old job, and within three months he found himself back at Wollstein.

Cohnheim, however, did not intend to allow Koch to be buried among the villagers, and in the summer of 1880, learning that Finkelnburg, a member of the Imperial Sanitary Commission, had resigned to resume his Bonn professorship, Cohnheim's impassioned advocacy caused Koch to be elected to regular membership in the commission. From this time on, Koch never left Berlin. He traveled in Asia and Africa and America, but his home address was always Berlin.

Koch's accomplishments wrought a transformation in the health department, medical statistics soon finding itself overshadowed by bacteriology—to the discomfiture of some of the elder members. In 1881, Koch dwarfed all his associates by his scheme of spreading liquid gelatin with meat infusion on glass plates, thus producing transparent solid media for pure cultures. This poured-plate method may be regarded as Koch's greatest single achievement, for there is no other method by which the bacteriologist can isolate pure cultures.

With these enormous gains in technique at his command, supplemented by new staining methods which he devised, Koch was prepared for the successful investigation of specific organisms, and on the evening of March 24, 1882, he startled the Physiological Society of Berlin by announcing his discovery of the tubercle bacillus. Because of its direct effects in the study of tuberculosis, and as a result of the impetus which this discovery gave to bacteriologic research, it ranks as one of the most important in the history of medicine.

It was in the foregoing paper that Koch laid down the four postulates that stand like four pillars on which has been built the superstructure of modern bacteriology: one, the microorganism must be present in all cases of the disease; two, it must be cultivated in pure culture; three, its inoculation must produce the disease in susceptible animals; four, it must, when injected into healthy animals, produce the same disease, thus completing the cycle.

In mid-August 1883, Koch departed from Berlin and in May 1884 he returned—between these two dates the average man had attended to his ledgers, but Koch had been in Egypt and in India studying the cholera, and not only discovered the cholera vibrio, but was able to cultivate it from drinking-water, food and clothing. These investigations opened a new era in public health.

In 1885 the chair of Hygiene and Bacteriology was created for Koch at the University of Berlin. At the same time he became the first director of the newly established Hygienic Institute. From all parts of Germany, and from various foreign countries, men came to learn the new methods and technique: to have studied under Koch was a passport to medical competence.

In 1890, Koch's announcement that he had discovered a remedy for tuberculosis, warmed the breast of Mother Earth with a strange hope and everywhere her afflicted children stretched their hands for the health-bringing vial. Alas, there are no Four Postulates in therapeutics, and tuberculin is looked upon as the one folly of a great scientist. As a therapeutic agent, tuberculin certainly has failed to fulfil the expectations which Koch prematurely raised, but as a diagnostic aid it has proved of immense value.

In 1891, the Institute of Infectious Diseases was opened in Berlin, with Koch as director. This institute, which had been built under his supervision, immediately became the headquarters of a vast amount of scientific activity.

In 1893, Koch erected another landmark in epidemiology by pointing out the relationship between epidemics and polluted water, and demonstrating that these water-borne epidemics can be largely prevented by filtration.

In 1896, the British government determined to solve some of the mysteries of the rinderpest which terrorized South Africa and Cape Colony. In this crisis, England turned not to one of her own sons, but to the leading spirit of the Institut für Infectionskrankheiten. Robert Koch accepted the burden imposed upon him, and remained in Africa until he devised a method of preventive inoculation which is still employed with success. While grappling with the rinderpest, Koch synchronously conducted valuable researches upon Texas fever, tropical malaria (which he supplemented by his Italian studies in 1898), black-water fever, sura and bubonic plague in Bombay. These were mere side-excursions for Koch, but would have made the reputations of a dozen lesser men.

In 1900, at the London Tuberculosis Congress, Koch set in motion unlimited argument by his contention that the human and bovine tubercle bacilli were not identical, thus deducing the fact that we have little to fear from the bovine type. It required courage on Koch's part to utter these views: because they were opposed to the opinions he had formerly published; because they were contrary to the generally accepted belief; and because they exposed him to the charge of being in the service of meat-dealers. The controversy still rages, but year by year the evidence is more in favor of Koch, and this much is certain: in the battle of mankind against tuberculosis, the chief foe of man is not the infected cow, but his infected fellow-man.

In 1902, his country sent Koch to German East Africa to study Rhodesian red-water fever, and incidentally he made important observations upon horse-sickness, recurrent fever and trypanosomiasis. At about the same time he established principles for the control of typhoid which have since become standard.

In 1905 the Nobel Prize was bestowed upon Koch, and before a single leaf of these laurels had time to fade, Koch headed the Sleeping Sickness Commission to German East Africa, English Central Africa and to the Victoria Nyanza. One result of this expedition, which lasted eighteen months, was Koch's introduction of atoxyl for sleeping-sickness.

In 1908, Koch came to America to participate in the International Tuberculosis Congress held in Washington. He was met in New York by a breezy young reporter who airily asked: "Well, doctor, what do you think of the future of medicine?" The foreign visitor seemed rather incensed at this brand of efficiency, and the writer has been privately informed that Koch referred to our gentlemen of the press as "lice pickers." This contribution of Koch's to current American journalism is brief, but not altogether insignificant.

In America, Koch had the pleasure of meeting some of the transplanted Kochs. He dwelt on scientific heights, but remained a simple and lovable member of his family, ever deeply attached to his childhood home. We doubt if even his little daughter was awed by the receipt of the following epistle:

> *Dear Trudchen!* It gave me great pleasure when mamma wrote me that you were good until now. I hope it will continue to be so. I wish you much happiness on your birthday. You will now be eight years old and you must be a sensible girl, learn well in school, help mother in the kitchen, tend flowers, feed the animals, and help me with microscopizing, clean slides and collect algies. All this you will have to do, and next year you will take away still more work from us, so that at the end papa and mamma will be able to sit in an armchair all day long, and our little Trudelchen will cook for us and microscopize for us. Ah, will that be a wonderful

time then! But now, don't stay away too long. The animals look for you in all corners every day, and Julka sighs all the time, and I, every time the door opens I think here comes my little girl, and when I look up it's only a stranger.

Come then, soon again to
Your loving Papa.

That Koch was human enough is clear from the circumstance that in his latter days he put away the wife of his youth, Emmy Fratz, for the charming Hedwig Freiberg. Countless poets and artists—and others—have effected similar transfers without commotion, but Koch's action to a considerable extent robbed his old age of the serenity to which Germany's greatest scientist was entitled. The government was displeased, his fellow-townsmen of Klausthal tore down the tablet which they had once proudly placed upon his house, and some of his closest relatives refused to speak to him.

No amount of criticism, however, could keep Koch from his work, and he stuck to his laboratories and lectures as long as his strength held out. On April 7, 1910, he spoke before the Berlin Academy of Sciences on the Epidemiology of Tuberculosis. Two days later the mark of death was upon him. The master's last days have been described with touching simplicity by his pupil and successor, Gaffky: "On the ninth of April, Koch became ill, although the day before he felt entirely well. His wife and the hastily summoned physician became very much alarmed. The following few days he felt better again, and hope alternated with forebodings. In spite of the most devoted care, his strength would not return, and even the slightest bodily exertion was followed by difficult breathing. In the middle of May, however, it was possible for him to undertake drives in the open, and the physicians thought it safe to grant his wish to be in a quiet place among green woods and pure air. On May 20th, accompanied by his wife, he undertook a journey to Baden-Baden. He stood the journey well, and felt better in the new surroundings. Then, on the twenty-seventh of May, the world received the message that Robert Koch died.

Sitting in a chair near the wide-open balcony window, on a beautiful evening, gently and without any struggle, he fell asleep."

The body was cremated, and the ashes deposited in the Institute which he founded. Over the urn that holds the dust that once was Robert Koch, there seems to arise the investigator's inspiring maxim—*Nunquam otiosus.* May it ever animate the workers in science.

II. HIS WORK

The foregoing survey of the main events in the life of one of the chief creators of modern medical science, is not studded with picturesque episodes, but with years of incredibly hard work that brought forth numerous important discoveries. Let us pause, and briefly review some of these productions.

A letter which Koch wrote in his twenty-second year, and which has hitherto not been published in English, is so characteristic of the coming investigator, that we quote it here. The subject deals with the trichinosis epidemic which during 1865 assumed such proportions in Hederslebe, near Magdeburg, that the medical faculty of Halle dispatched four young physicians to the scene, while Virchow sent there his favorite and foremost pupil, Julius Cohnheim. But the paths of Koch and Cohnheim were not destined to cross for more than another decade. Koch's cultured uncle, Biewend, who employed his leisure with the microscope, and spent many interesting hours in preparing and drawing trichinæ, suggested that his nephew tackle the problem, and offered him 150 thalers for traveling expenses. Koch's reply came from Göttingen:

Dear Uncle: I saw with great joy from your letter of December 4th, that you take an interest in my career and I feel very grateful to you, and because of this I cannot consider your plan and your kind offer. I hope to be able to convince you that I do not reject this tempting offer recklessly or thoughtlessly. It is my conviction that our knowledge of trichinosis and of the surrounding conditions has too many lapses. The appearance of the immigrating trichina in the human organism is very well known, so that anyone familiar with the disease can easily recognize it, also the changes found through dissection have been sufficiently investigated. On the other hand, until now only the direct precaution-measures concerning the transferring of the trichina from hog to man are known; how we can prevent the trichina from reaching the hog, only vague surmises exist, as nothing certain is known regarding the original seat of the trichinæ.

The weakest point, however, is the treatment of the disease, as there is no specific, no rapidly working means for killing the trichina in the human alimentary canal or during their migration into the muscles; I do not consider the existence of such impossible, but it seems to me very improbable, as during the stay of the trichinæ in the intestines an energetic physic does the same service. After immigration and at the beginning of encapsulation no treatment is necessary, for fatal results are due to the extraordinary irritating condition which the trichinæ create while passing through the organism, while as repeated experience proves, a human being can bear the encapsulation in tranquillity and without harm. A remedy, therefore, is necessary during the period of the migration; it is easily to be seen, however, that in the weakened condition of the patient, it would be easier to kill him than the powerful trichina. It would be folly *a priori* after such an observation to doubt altogether the possibility of such a remedy, especially when we take into consideration the fact that there are poisons which certain animals can bear while it is possible to kill people and other living beings with them, so that the existence of such a substance cannot be denied, an agent which would stand in similar relationship to a human being and a trichina, in a manner that the former could be saved and the latter destroyed through its effect. At all events acids and alkalis cannot serve for this purpose as they never enter the fluid mass unchanged, but become neutralized partly in the acid and partly in the alkaline digestive secretions, or if this is not the case, as is true of all corrosive poisons, act destructively upon the spot but not where the trichina rests in safety. Mineral preparations, particularly quicksilver—metallic quicksilver according to all experiments should never enter the organism—act too slowly and too weakly, while greater doses may prove dangerous; apparently nothing remains but the plant remedy.

You will perhaps now agree with me that these two chief questions, the origin of the trichina for the purpose of being able to destroy it at its source, and the specific treatment of the already raging epidemic, should be investigated not so much during an incidental epidemic as through a careful examination of all objects which serve as food for hogs (some claim to find it in rats and mice which are often eaten by hogs, others in moles and shrew-mice) and further through carefully-conducted experiments on suitable animals, since we cannot misuse the unfortunate all-too-sick human being for such purposes. Such experiments, should they have in view the necessary finality for practical application, would take, not months, but years perhaps of study and considerable expense. Such a prolonged undertaking would carry me too far from my present purely practical aims, and I have to, therefore, renounce it.

Concerning some of the other questions in your letter: it is absolutely proven that the trichina can be found only in the striated, the so-called voluntary, muscles. (The way along which they reach there has not yet been established, also a point which could be settled only through experiments upon animals.) Regarding their resistance to temperature, very accurate researches have been made by Kuechenmeister and Fiedler, which show that at 50–60° R, when albumin coagulates, the trichinæ are surely killed, but the middle parts of large pieces of meat after an hour's cooking, especially roasting, do not reach this temperature. As I have accidentally received from Prof. Krause, meat with encysted (found here accidentally during dissection) and also free trichinæ, the latter a recent death-case in Hedersleben, I have made several preparations and will take pleasure in sending them to you just as soon as the sealing wax reaches the necessary firmness. I hope, dear uncle, that I have been able to convince you as to the correctness of my action and that I shall be able to retain your good will for the future. I am, again thanking you many times,

Your affectionate nephew,
R. Koch.

Koch's first published work was his Göttingen thesis of 1865, On the Occurrence of Ganglion Cells in the Nerves of the Uterus. It is interesting to note that this maiden essay was abstracted by Koch's unique teacher, the illustrious Jacob Henle, and published in his Journal of Rational Therapy. Henle, who evolved the modern germ-theory of disease and foreshadowed the Four Postulates, lived to see his hypothesis transmuted by his pupil into the cardinal fact of scientific medicine. The same volume of Henle's journal contained an abstract by the distinguished physiologist Meissner of Koch's first and only venture in the domain of bio-chemistry—On the Origin of Succinic Acid in the Human Organism. Then came that momentous silence of ten years, but when Koch spoke again, it was with the voice of authority. His work, The Etiology of Anthrax Based on the Life History of Bacillus Anthracis, published in Cohn's Contributions to the Biology of Plants, was the clarion call of a new leader.

Fifteen years later, when the Institute for Infectious Diseases was founded, W. Becher of Berlin published a biography of the director; the biographical data, however, were scant, the volume being mainly devoted to the technical aspects of Koch's various discoveries. As this work has never been published in English, we may freely quote some of its synopses, written while Koch was in full activity. We have already referred to Koch's Procedures for the Examination, Preservation and Photography of Bacteria, which like Koch's previous work originally appeared in Cohn's Contributions to the Biology of Plants. After enumerating the serious difficulties that lay in the way of the study of the bacteria, Koch explained how he placed the bacteria-laden material in a thin layer on a cover-slip, and how he stained the bacilli with anilin dyes, a procedure which Koch borrowed from Carl Weigert who showed the ability of bacteria readily to absorb and permanently retain anilin dyes. In photographing bacteria, Koch employed the apparatus constructed by that expert in microphotography, Gustav Fritsch. Koch demonstrated that bacteriology would make great advances with the aid of photography, as it was evident that the photographic plate could reproduce the microscopic picture better or much more sharply than the retina of the eye.

On the plate it was easy to distinguish clearly such changes in the shape of the bacteria as even the most experienced eye could not distinguish formerly in the microscopic picture. In this way Koch succeeded with the aid of photography in discovering many new facts concerning bacteria and in demonstrating them to others with absolute certainty. For example, he was the first to demonstrate, by staining, the flagellæ of the motile bacteria, thus confirming the older but doubtful observations of Ehrenberg, Cohn and others. Next he taught how to distinguish the various types of spirochetes which had become very much confused, such as the spirochetes from marsh-water, those from the gums, and those found by Obermeier in relapsing fever.

Following close upon this work, came Koch's great memoir of 1878, Investigations into the Etiology of Traumatic Infective Diseases, which Watson Cheyne translated for the New Sydenham Society in 1880. In these investigations, Koch really introduced the Abbe condenser and the homogenous immersion system into microscopy. The effect of diaphragms on the field of vision was well known: a small diaphragm darkened the field but brought out the structure of the object; conversely the more the diaphragm is opened, the brighter does the picture become, but the less clear is the structure. In illuminating his object for photographic work Koch did not use the ordinary concave mirror but a lens or condenser with a short focal distance and in front of this he placed diaphragms of varying widths. If he used a narrow diaphragm the preparation would be struck with a narrow cone of light composed of almost parallel rays; as the opening was enlarged the base of the cone of light became proportionately larger without changing the focal distance. At the same time the visual field became brighter and the structure component became less and less clear whereas the color component stood out the more sharply. These observations showed that the color picture would be clearest when the cone of light originated from the largest possible aperture. These conditions were best satisfied by the Abbe condenser which consisted of a system of lenses whose focal distance reached only a few millimeters in front of the foremost crystal. When this combination of lenses was placed in the opening of the microscopic stage a little below the stage level, the focal point coincided with the object to be examined which in this position received the most favorable illumination. It was with this condenser that Koch equipped his microscope, placing diaphragms between his condenser and concave mirror. When examining a stained section with the aid of this apparatus he obtained an increasingly brighter picture the wider he opened the diaphragm. However, the structure component kept losing in the clearness of its outlines, becoming increasingly pale and finally disappearing altogether, whereas the color component stood out more and more intensely until it overshadowed the whole microscopic picture. It was now a simple matter to see clearly microörganisms that had formerly been invisible or were seen very imperfectly. What had formerly given the appearance of confused lines or points, could now definitely be made out as bacilli or cocci. As the actual result of his investigations, Koch was able to claim, first, that each of the infectious diseases investigated corresponds to a form of bacterium characterized not only by a constant physiologic action on the infected organism but by a characteristic size, growth, and form; and secondly, that we thus establish, not only the advisability, but even the necessity of distinguishing just so many definite forms of pathogenic bacteria.

Koch's letter to Ferdinand Cohn, a Further Contribution to our Knowledge of Febris Recurrens and of the Spirochetes, together with his work on the Transmission of Recurrens-Spirochetes to Apes, were published during 1879. The year 1880 marked the removal-period from Wollstein to Berlin, and in 1881, in the capacity of a member of the Imperial Health Board, Koch published papers on the Etiology of Anthrax, on Disinfection, on Disinfection with Hot Air (with Wolffhügel), on the Value of Superheated Steam for Purposes of Disinfection (with Gaffky and Loeffler), and on the Accommodation

Theory of Molds. This same year witnessed the publication of his paper, The Investigation of Pathogenic Microörganisms, which contains his first reference to his invention of transparent solid media, the introduction of which opened up a new world for bacteriologists. Up to that time two kinds of media had been in use, either a fluid one which was transparent, or else a solid one which was invariably opaque. Both suffered from serious deficiencies. In the fluid media the germs grew in a wild and irregular manner so that to study them under the microscope was impossible; whereas, while the solid, opaque media offered no difficulty to the fixation and isolation of the microbes, they were, by their very opacity, insusceptible of observation with the microscope. It was a fortunate inspiration that came to Koch whereby he combined a third medium from these two, the new one being both solid and transparent. This he accomplished by converting the ordinary fluid media into solid ones by the addition of a coagulable substance. As a fluid medium Koch first used simple beef broth and as a coagulable substance, gelatine, which, when added to the medium leaves the latter absolutely transparent. Later the procedure was modified in many ways, at least as far as the nutritive medium was concerned. In addition, Koch learned how to obtain a very useful, transparent, solid medium from the blood serum. The nature, as well as the applicability of the improvement, however, remained the same. The first advantage is that with the solid, transparent medium it is possible to isolate the individual bacteria and to obtain really pure cultures. In the second place there is the advantage that the cultures can be studied microscopically with the greatest exactitude as regards their biological characteristics. It is out of this transparent solid medium that Koch developed his method of plating which has since been one of the most fundamental of bacteriological procedures.

On Monday, April 10, 1882, when Number 15 of Carl Anton Ewald's *Berliner Klinische Wochenschrift* appeared, the opening contribution was the immortal paper which Koch had read seventeen days before at the Physiological Society. A complete report on the Etiology of Tuberculosis was given to the world during 1884 in *Mittheilungen aus dem Gesundheitsamte.* The forty years which have passed since its publication have stamped it as an imperishable classic which should form part of every medical man's education. The interested reader will find Stanley Boyd's excellent translation of the complete report in Watson Cheyne's *Recent Essays by Various Authors on Bacteria in Relation to Disease,* published by the New Sydenham Society (1886). This volume likewise contains Victor Horsley's translation of Koch's *On the Investigation of Pathogenic Organisms,* George Lockwood Laycock's translation of Koch's *Etiology of Cholera,* and Arthur Whitelegge's abstracts of Koch's papers on *Disinfection,* and throughout the contributions by other investigators the name of Koch appears over and over again.

On February 2, 1884, the discoverer of the tubercle bacillus was able to send the news from India to Germany that he had discovered the germ of cholera. From this historic report we quote a few passages:

> The question brought up in my last report, as to whether the bacilli found in cholera intestines belonged exclusively to the disease, may now be regarded as settled. At first it was extraordinarily difficult to arrive at the truth owing to the varied pathological conditions produced in the cholera intestine, as well as because of the great number of bacteria always present in the gut. In the great majority of instances death occurs not from the intensity of the cholera process itself, but in the resulting reactive period in which there occur such significant changes in the characteristics of the intestine and its contents that it is impossible from such cases alone to obtain a clear picture of the cholera process proper. It is only when one has had opportunity to autopsy a large number of uncomplicated cases and to compare these with fresh infections that one can get a proper insight into the pathology of the disease. For this reason it was necessary to exercise the greatest circumspection as to the significance of our findings regarding the cholera bacilli and to suspend judgment as to their causal relationship just as long as convincing evidence was still lacking.

In my last report I duly announced that we found certain characteristics in the bacilli of cholera intestines which enabled us to differentiate them definitely from all other bacteria. Of these points the following are most characteristic: The bacilli are not quite straight like the others but a little bent, just like a comma. This curvature may go so far as to cause the bacillus to assume the shape of a semicircle. In pure cultures, these curved rods may give rise to S-shaped figures and variably long wave-shaped lines, the former corresponding to two individuals and the latter to a large number of comma bacilli, these appearances being due to their remaining together after rapid proliferation. They are motile, a feature which is best observed in a hanging drop preparation on a coverslip. Under such circumstances the bacilli can be seen traveling in all directions across the microscopic field with great rapidity.

Very characteristic is their behavior in nutrient gelatine where they build colorless colonies. These appear closed as if composed of numerous very shining glass fragments. Gradually these colonies fluidify the gelatine and spread out over a large area. Accordingly this characteristic appearance in gelatine cultures makes them easily distinguishable and they can be readily isolated from other bacterial colonies. When grown in hollow ground slides it can be shown that they always frequent the sides of the drop of nutrient fluid where they can be readily recognized by their characteristic movements, and, after the application of aniline dyes, by their comma shape.

Up to the present we have examined twenty-two cholera bodies and seventeen cholera patients. All these cases were immediately investigated for the presence of specific bacteria by the method of gelatine cultures, by microscopic preparations, and by cultivation in hollow slides, and in every single case comma bacteria could be demonstrated. This result, taken together with those obtained in Egypt, justifies the conclusion that this form of bacillus occurs regularly in cholera intestines.

As controls, there were examined in exactly the same way: twenty-eight other bodies, including eleven dysentery cases, the evacuations of a case of simple diarrhea, of dysentery, and of cured cholera, various healthy subjects, as well as animals dead of intestinal ulcerations and pneumonia, as well as water contaminated with putrid material, such as stale city water, water from dirty

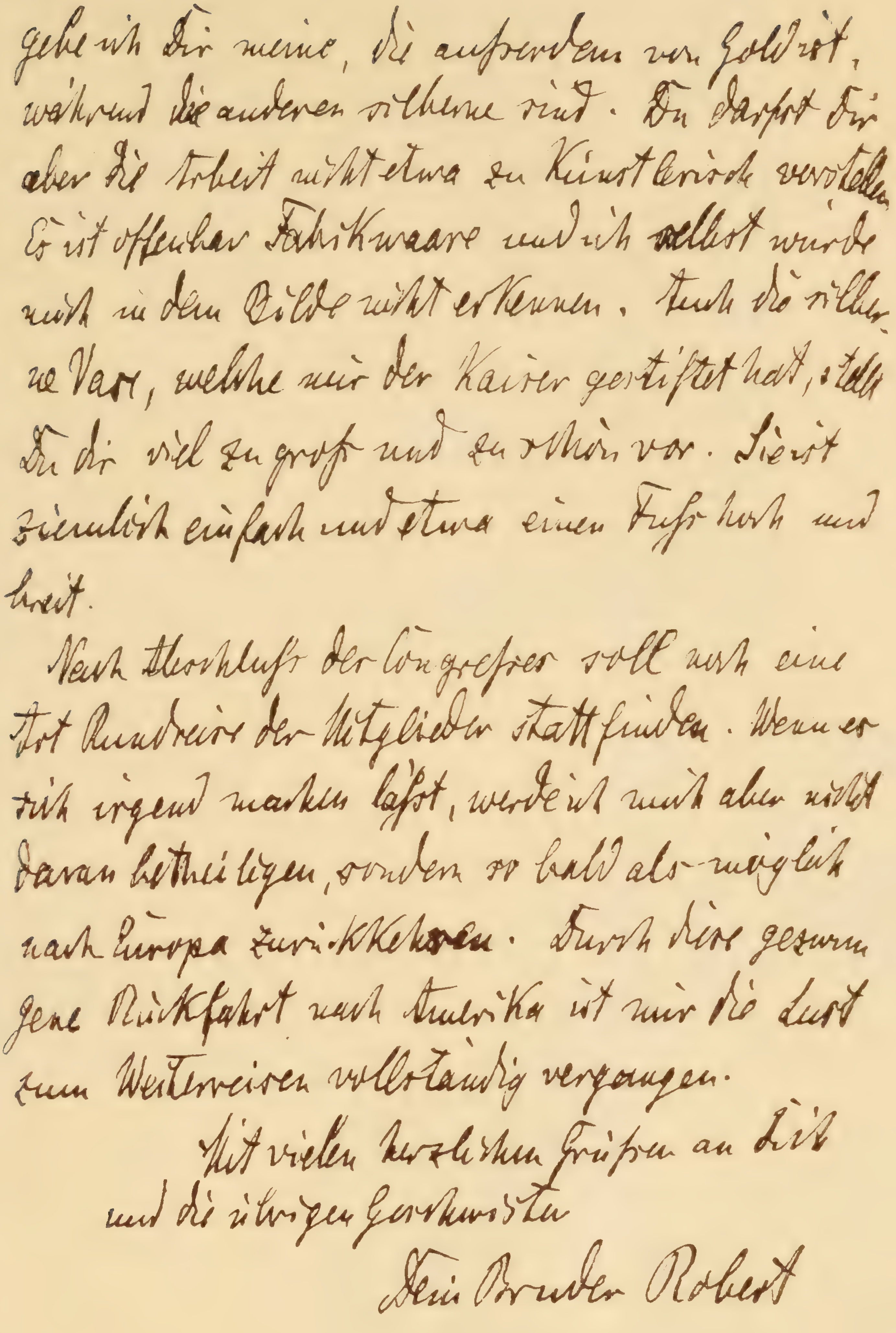
> swamps, swamp mud, and dirty flowing water. However in not a single case, whether human stomach or intestine, or that of animal bodies, nor in the evacuations, nor in any of the fluids otherwise rich in bacteria, were cholera bacilli to be found. Since a disease picture very similar to that of cholera can be produced from arsenic poisoning, such an experiment was actually performed and an animal was examined after arsenic poisoning for the presence of comma bacilli in the intestines and stomach but with negative results. From these results it is further evident that comma bacilli are characteristic only of cholera.

Whoever reads the full report will find that Koch felt confident the comma bacillus was the specific organism, although he had not inoculated animals with it. In fact, Koch believed animals to be immune to the cholera vibrio, declaring:

> It is much to be desired that, with these bacteria, a disease similar to cholera could be transmitted artificially to animals in order that the causal relation of the bacteria to the disease might be demonstrated objectively. This has not yet been accomplished and it is rather doubtful whether it can ever be done, since to all appearances animals are not susceptible to cholera infection. Should any species of animal have succumbed to cholera this would have been observed in the Bengal where the cholera infection is widespread the whole year round and throughout the whole country. Nevertheless, all communications on the subject are negative as to this having happened.

Koch must have been much dissatisfied with this bacteriologic gap, for in spite of his admission that "it is rather doubtful whether it can ever be done," he himself later succeeded in rendering guinea pigs exceedingly susceptible to cholera, and thus he made his discovery pass the severe test of his Four Postulates.

An adequate account of Koch's African achievements would be a volume in itself. Perhaps none of these expeditions was more interesting than his last—to the land of sleeping sickness. Upon his return, Koch delivered before the Deutsche Kolonial-



gebe ich Dir meine, die außerdem von Gold ist, während die anderen silberne sind. Du darfst Dir aber die Arbeit nicht etwa zu künstlerisch vorstellen. Es ist offenbar Fabrikwaare und ich selbst würde mich in dem Bilde nicht erkennen. Auch die silberne Vase, welche mir der Kaiser gestiftet hat, stelle Du Dir viel zu groß und zu schön vor. Sie ist ziemlich einfach und etwa einen Fuß hoch und breit.

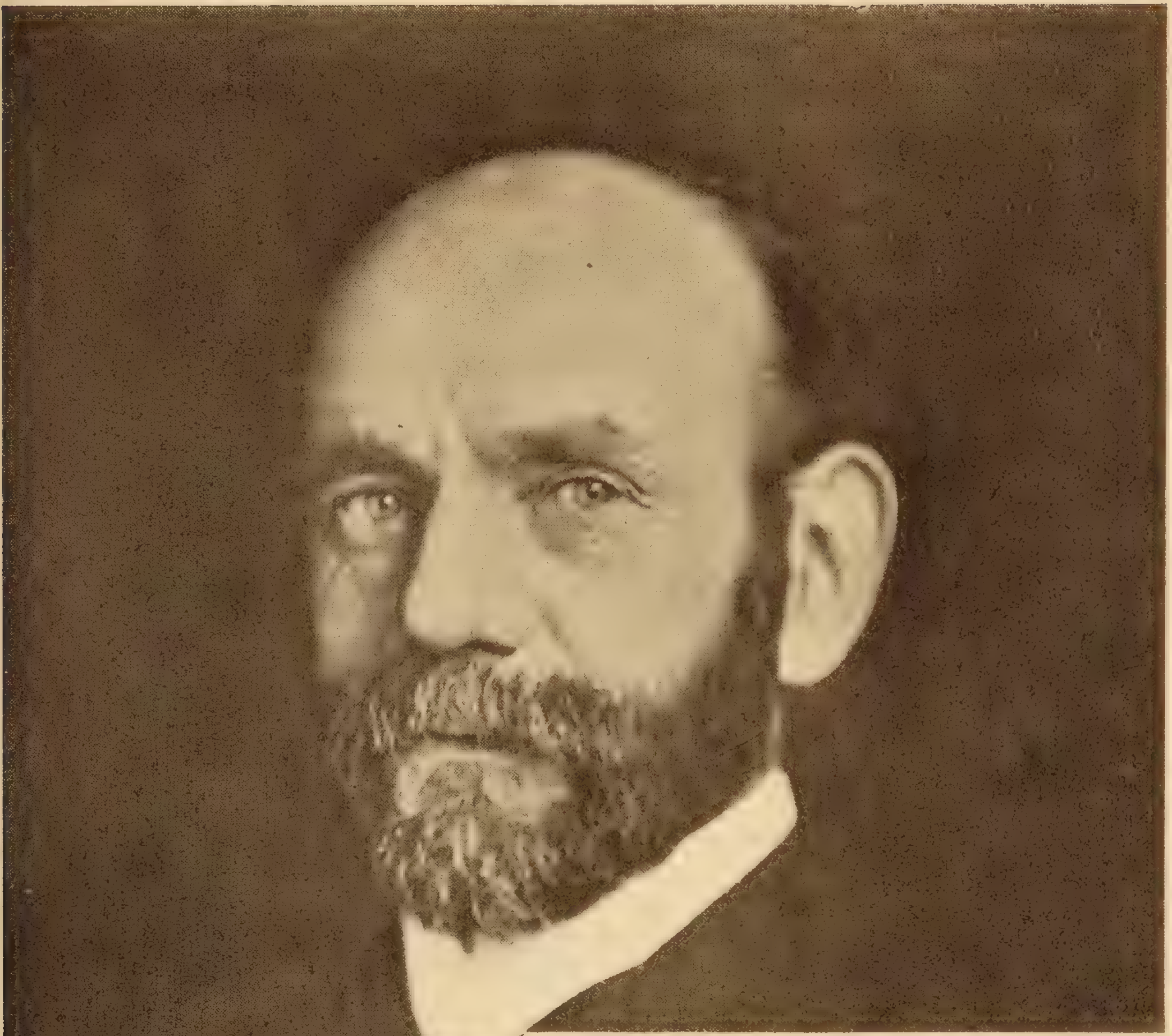
Nach Abschluß des Congresses soll noch eine große Rundreise der Mitglieder stattfinden. Wenn es sich irgend machen läßt, werde ich mich aber nicht daran betheiligen, sondern so bald als möglich nach Europa zurückkehren. Durch diese gezwungene Rückfahrt nach Amerika ist mir die Lust zum Weiterreisen vollständig vergangen.

Mit vielen herzlichen Grüßen an Dich
und die übrigen Geschwister

Dein Bruder Robert

HANDWRITING OF ROBERT KOCH

A page from a letter to his brother Arnold.



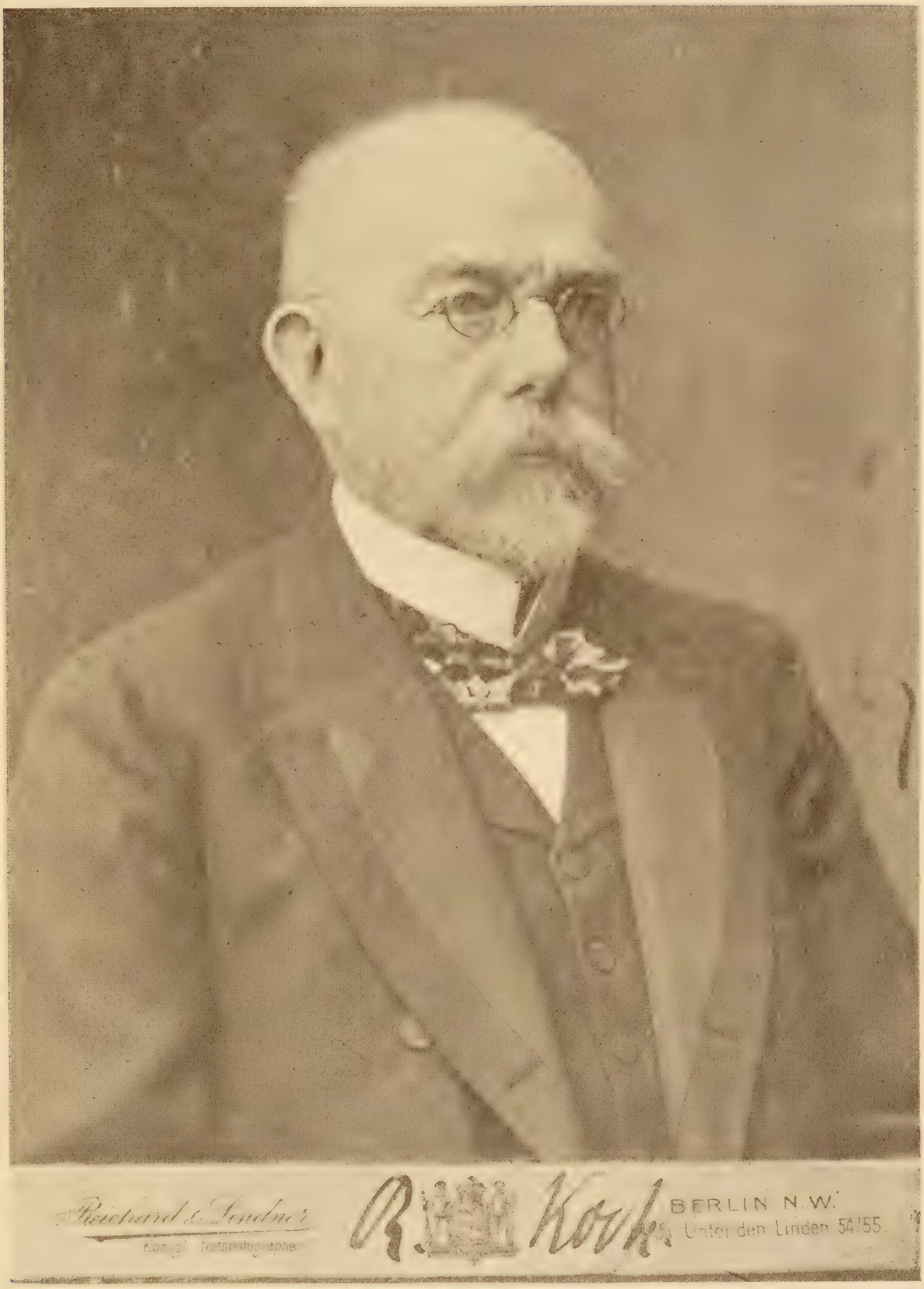
(Above)

ARNOLD KOCH

Brother of Robert Koch, and Father of Waldemar and Mathilde Koch.

(Below)

WALDEMAR KOCH



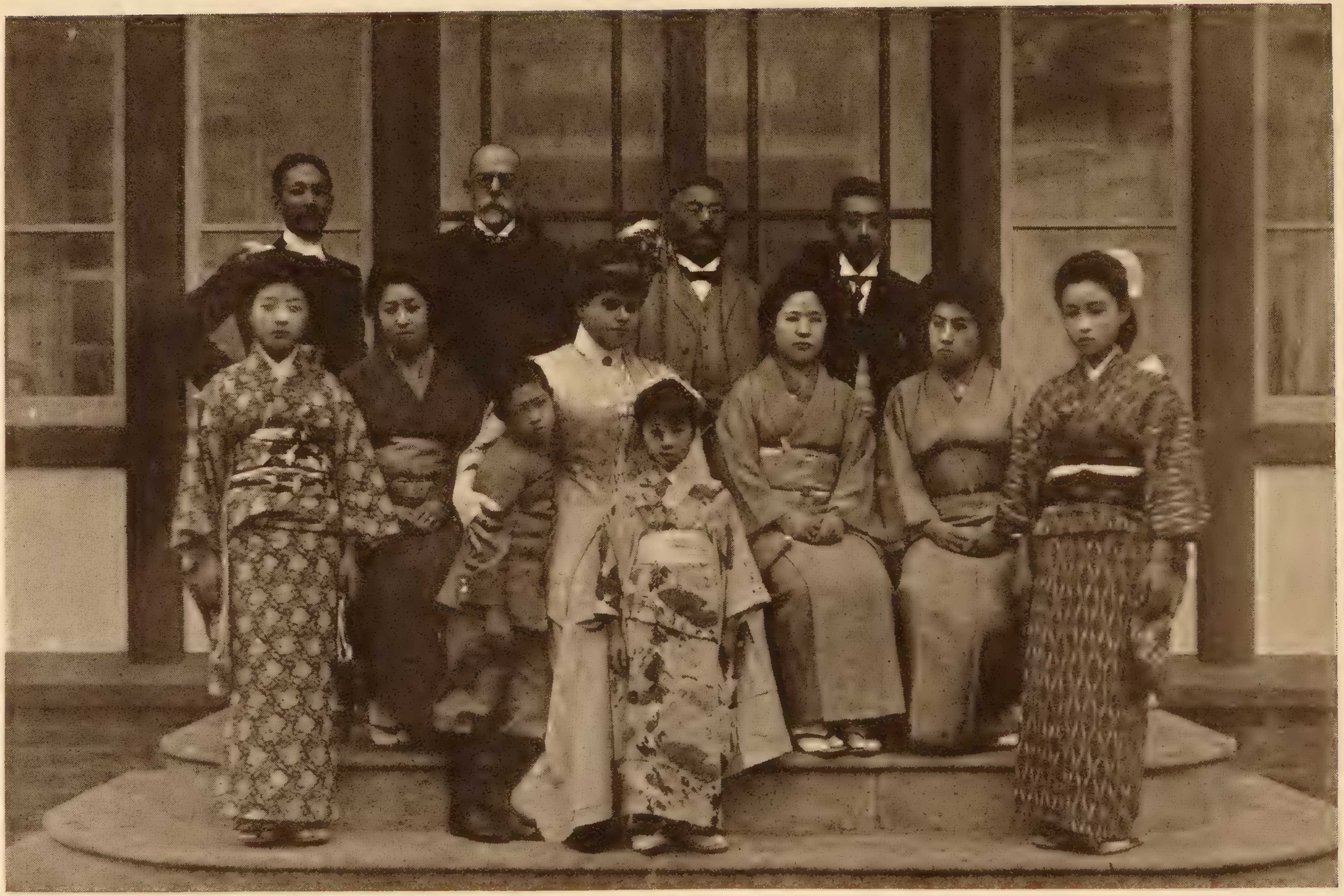
AUTOGRAPHED PHOTOGRAPH OF KOCH

BUST AT THE ROBERT KOCH INSTITUTE OF INFECTIOUS DISEASES

R. Koch.

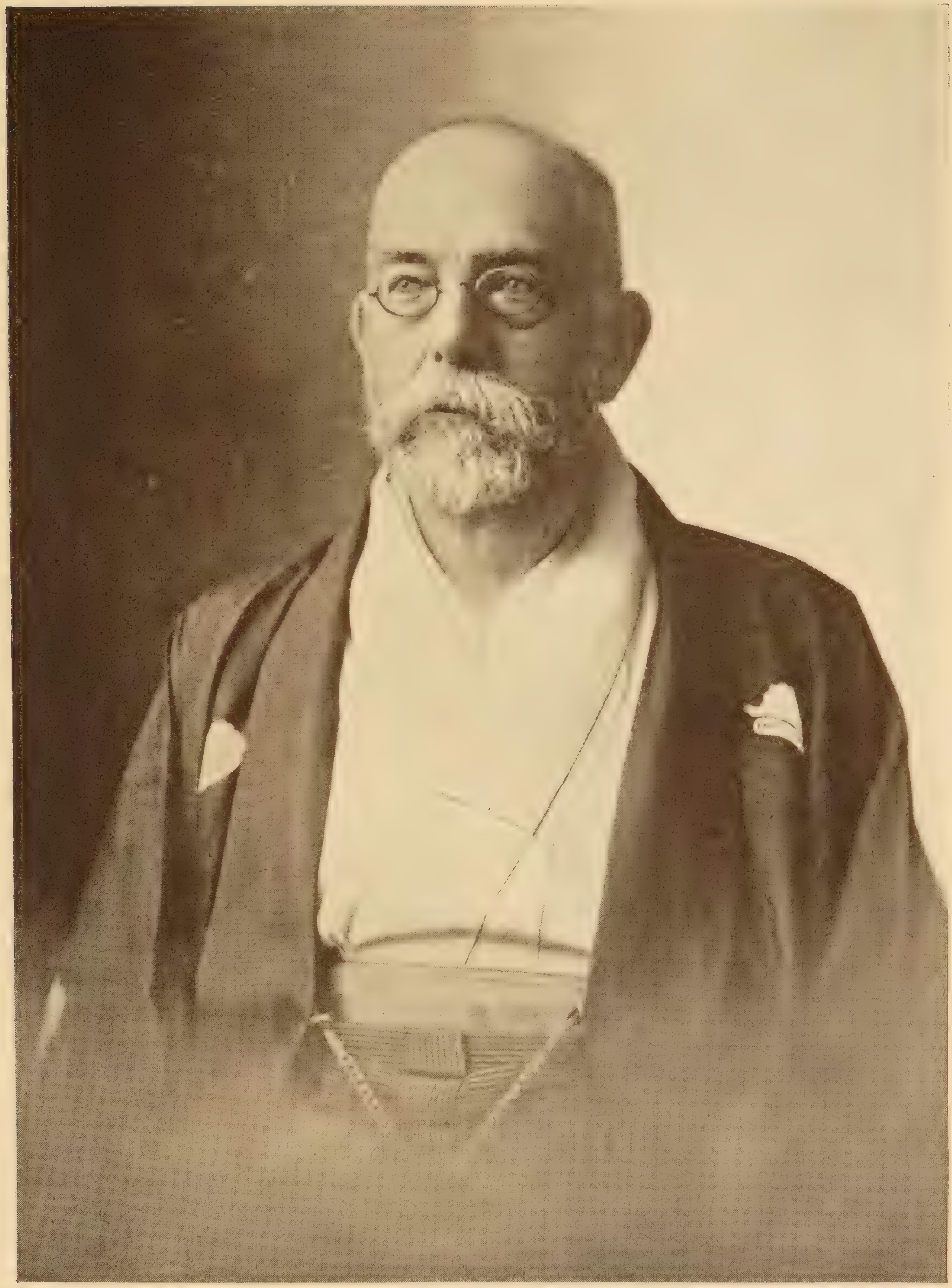
ZUR ERINNERUNG AN DEN BESUCH VON
S. EXCELLENZ PROF. DR. ROBERT KOCH IN JAPAN
JUNI 1908

POSTAL OF KOCH
Published in Japan in 1908.



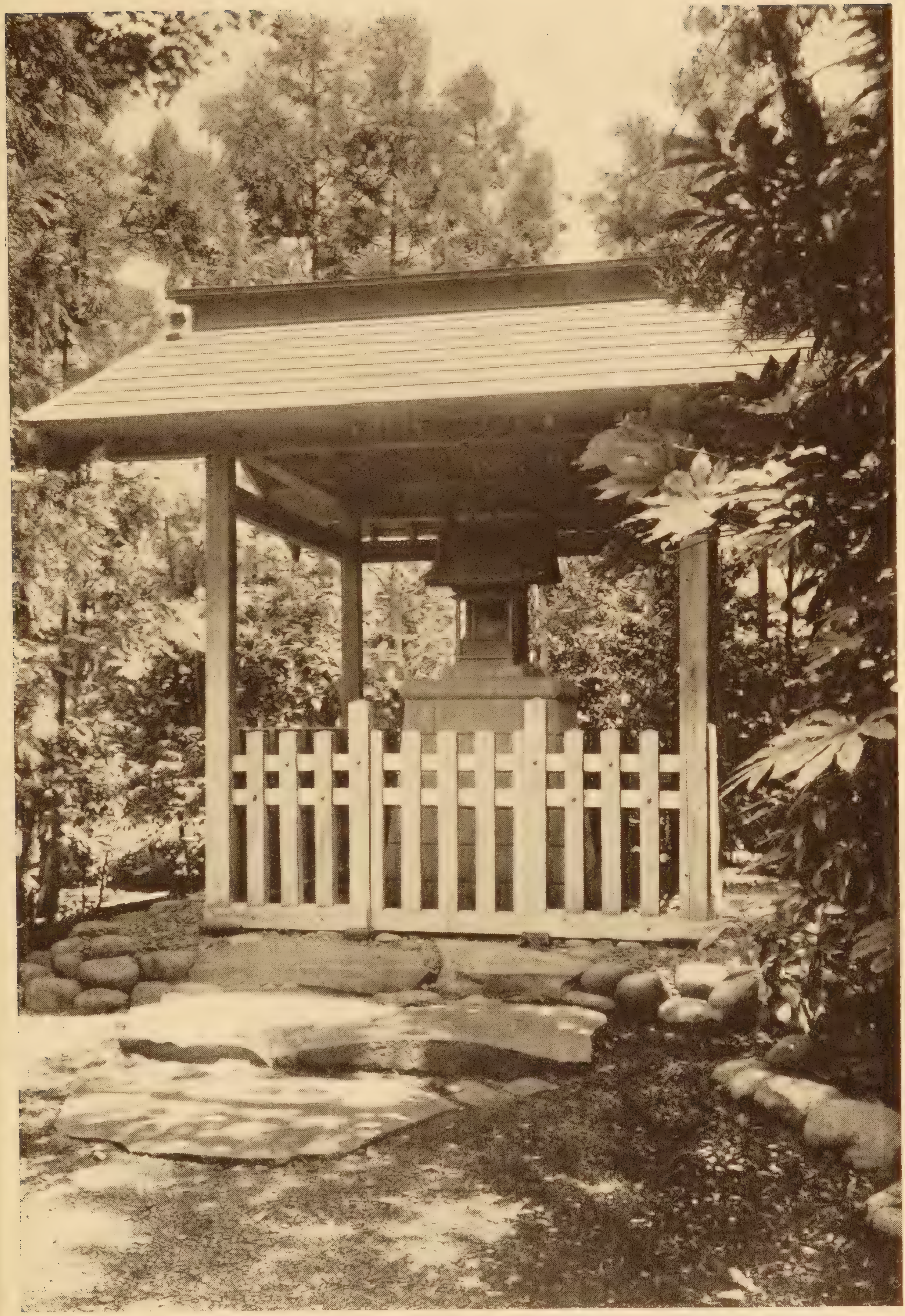
ROBERT KOCH IN JAPAN

At his left stands Kitasato, the Japanese Koch. In the foreground is seen Koch's wife, Hedwig Freiberg, with two Japanese children in her arms.



ROBERT KOCH IN JAPANESE COSTUME

Courtesy of S. Kitasato.



TEMPLE TO KOCH IN JAPAN

gesellschaft a lecture which we cannot refrain from presenting in an English version, since it will come as a surprise to those who know Koch solely through his technical publications. Nothing written about the tropics surpasses it for simplicity, vividness and color:

> For the past two years the interior of Africa has been afflicted with a deadly plague which has been named after its most striking symptom—sleeping sickness. This disease rages especially in the Congo and along the north coast of the Victoria Nyanza. Hundreds of thousands of human beings have already been snatched away by it, and the disease is still spreading. German East Africa has fallen into danger, and it was for this reason that our government sent there a scientific expedition, in order to study this disease most carefully, and if possible to avert the menace which threatened our colony. The leadership of this expedition was assigned to me. We installed ourselves on the Island of Sesse, where the sleeping sickness was at its worst. Prior to the outbreak of this plague there were 30,000 inhabitants; in a few years 20,000 died of the disease, and there were hardly 10,000 people left alive. It could, moreover, be stated with certainty, that of the survivors at least one half were already infected, and would succumb to the disease, unless the healing art could save them.
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> The natives of the Sesse Island live together in villages. The houses, of course, are not closely adjoining as for instance in our country, but the huts are located in the midst of banana groves. It has been estimated that from 400 to 500 banana trees suffice to maintain a native family for one year. Such a banana-plantation forms a grove around a hut, and several of these groves then make a village. There are villages consisting of 1000 banana groves. The bananas are not used as fruit; they are cut before they are ripe. Then they are peeled, stewed to a mush, which resembles our mashed potatoes, but has a much more pleasant taste. The bananas of the Sesse Island are unusually large. In order to satisfy their need of nourishment, the people are obliged to consume this mush in large quantities. The children eat so much of it that they get what may be called banana-belly, as for instance our children get potato-belly. Besides bananas, sweet potatoes, taro, maize and other vegetables are cultivated, and small dried fish are used in addition;

all this, is of little importance to the question pertaining to nourishment. Banana mush, however, the people eat year in and year out as the banana-tree bears fruit all year around, and it needs but little care, so that the food problem of the population is a very simple one.

The question of clothes too is not subject to fashion as much as in our country. In their banana groves, the natives have the so-called bark tree, from whose bark by means of simple pounding with wooden rods, they produce cloth-like material. From this tree, somewhat resembling the fig, the bark can be peeled off three to four times, as it grows again. This bark material is worn by men and women in different ways. The men tie it into a knot on one shoulder, leaving the other shoulder free; the women leave both shoulders free, and usually pull it together over the breast. The material when torn is not mended.

The coffee plant too flourishes in this climate, and amidst banana groves it attains tree-like proportions. The beans are small, resembling the mocha and make as good a beverage, but never reach the export stage to any extent, first, because the natives take no interest in cultivating this industry, and second, because the sultans have declared the trees their property and demand the coffee harvest for themselves.

The fertility of the Sesse Island is due to the peculiar climate, which results from its latitude in the Victoria lake. The Victoria Nyanza, in whose northwest corner lies this group of islands, has a surface of 70,000 square kilometers. As it is under the equator one would imagine that the climate is real hot. That, however, is not the case. The interior of Africa forms a high plateau and has therefore a considerably cooler climate than the coast. One has not the sensation of being under the equator. Besides, the climate is affected by the sea and by the blowing winds. The prevailing air current blowing from southeast to northwest comes from the steppes which lie in the east; it saturates itself with the moisture and arrives at the west coast as moist, cloud-forming and rain-inclined air. The result is that the eastern and southern sections of the sea have a different climate than the western and northern parts. In the east and in the south the steppe climate prevails, and in the west and in the north a damp, rainy climate. The wind currents are usually so strong that at the Victoria Nyanza high billows are noticeable. It does not then appear like a lake but could be taken for an open sea. The lake traffic is very brisk and is now carried on by English steamships. However, until a short time ago, only boats of the natives could be utilized. Even our expedition used a large row boat of this kind which at one time was the property of a chieftain. The boats of the natives are of various sizes: the smaller ones have just a pair of rowing seats, but the larger ones, such as ours for instance, have ten to fifteen so that large boats with two oars to each bench can have as many as thirty oarsmen. Two men are continuously occupied in bailing out the water, which runs in through all the crevices, as the people do not know enough to draw the seams closer together. This is peculiar, as they have all the material necessary since they can use the gum juice or the aromatic resin of the incense tree, of the Canarium edule, which the natives call Mwaffu. Under these circumstances each boat has to be thoroughly examined before using, as on account of the high waves, the voyage in itself is already dangerous. If the boat capsizes, or meets with any other serious mishap then the people are lost beyond all hope, as the lake swarms for miles with crocodiles.

The shore of the lake is fringed with a strip of primeval forest through which it is difficult to cut a path. On account of this, the natives cut clearings so as to make landings for their boats, and when necessary footpaths are also laid. Towards the interior the forest stops abruptly. It is along the water edge of this coast-forest, that the flies can be found which inoculate man with sleeping sickness. This fly, Glossina palpalis, lives exclusively on blood. It is necessary for these flies to suck blood every few days. But what kind of blood? To ascertain this was the important question of the expedition. Human beings do not frequent the lake and the primeval forest often enough to furnish opportunity to the glossinæ to suck blood. Something different must then be the case. We first surmised that it must be the many water birds, as we would always see the birds and the flies together. In order to decide this question more than a thousand glossinæ were caught in different places and the contents of their stomachs examined. Not the expected blood of birds was found, however, but the blood of crocodiles. Nothing else then remained than to also investigate the blood of the crocodile, as it now became certain that the crocodile played some rôle in the question of sleeping sickness. It was even possible to count upon the probability that the crocodiles which were stung by the glossinæ harbored in their blood the trypanosoma, the parasite of sleeping sickness. It was, therefore, necessary to investigate them.

To obtain crocodiles, however, was not so simple. The natives are not able to kill them with their spears, and we, therefore, were ourselves obliged to go hunting them. Well, the crocodile is a shy animal, and it is not easy to overtake it. The best way is to try to surprise it at its nest. The crocodile, as is known, lays from sixty to seventy eggs in a hole in the sand, covers them again with sand and allows the sun to hatch them. But it often returns to the nest, not perhaps to hatch the eggs, but to protect them from any possible enemy. After a great deal of effort, I was successful in catching such a crocodile near its nest. We found a nest near the water resembling the nest of a crocodile, inasmuch as it was leveled and altogether stripped of all vegetation, from which led a path to the shore that the crocodile made for itself. My people, however, were in such fear of the animal that they could be induced to uncover the eggs only after I placed myself directly in the crocodile's path. Soon a mighty crocodile came out of the water. A bullet into the brain laid it low close to its nest. When the sand is carefully lifted from the eggs, smaller eggs will often be found near by, which another amphibian has entrusted to the care of the mighty crocodile. We took at once fresh blood from the crocodile in order to make preparations and cultures, and we had luck in this case, as the cultures were a success, and through them many important scientific results were obtained. It could now be definitely ascertained that the blood of the crocodile did contain trypanosomæ, but not those producing sleeping sickness.

It was now further necessary to experiment with living crocodiles. As it is impossible to hunt the adult animals, we helped ourselves by burying the pilfered eggs into the ground near our camping place and waited until the sun hatched them into young crocodiles. Our glossinæ were fed on these young animals, and we were able to convince ourselves that these flies do live on crocodile blood, though, of course, not exclusively. Other amphibians as for instance hippopotami, may, here and there be the blood suppliers; the chief need of blood, is however, satisfied by the crocodiles.

The glossina palpalis is somewhat larger than our housefly. When it rests, it immediately becomes striking by the characteristic position of its wings. The wings are laid one over the other, like the blades of a pair of scissors. Besides this, it has a rigid proboscis, which our housefly lacks. Not all glossinæ are germ-bearing; only those whose proboscis contains the trypanosoma are able to produce sleeping sickness. On examining a great many glossinæ, we found the trypanosomæ in but a few. People who are employed along the shore are particularly subject to the sting of the glossinæ, as they are always on the water where they find their food. However, they are not always present along the entire shore of the Victoria Nyanza, but only in such places where there are bushes on which they can rest. They prefer individual bushes, standing alone, especially the Ambatsch-bush, which grows in the marshes along the waterfront of the forest so abundantly, and which together with the papyrus-thicket makes approach to the water difficult or altogether impossible. Often a single bush may be found standing in the water. This Ambatsch-bush, Herminiera elaphroxylon, is known for its light wood, the so-called cork, which is utilized by fishermen for their nets.

The glossinæ do not fly in swarms, but approach singly; first one, then a second and third, and soon there are so many, that the victim whom they have chosen, finds it impossible to defend himself. We were, however, able to protect ourselves in that we caught one after the other as they came flying. This was made easy for us, as these flies like to alight upon dark objects. For that reason one of my companions was draped in a dark cloth, while we others wore light garments. A second member of the party, with a mull net caught the flies, which were attracted to the black cloth. The natives pay no attention to the sting of the fly, and do not believe that the sleeping sickness originates from it, as they say our fathers were also bitten by the fly and did not get the sleeping sickness. The first victims of the sleeping sickness were the people working along the shore, in other words, the fishermen, oarsmen and the gum-gatherers as the gum plant flourishes only in the shore forest, where the people, occupied with collecting the gum-juice are continually exposed to the bite of the fly. When a person is bitten by this infecting fly, the sickness does not manifest itself immediately, but only after weeks, months or even years. The first thing that is conspicuous in the afflicted person, is the swelling of the lymph-glands, especially in the neck; but in other places, too, such swellings may occur, as for instance in the eyelids. As the disease progresses, there appears paralyzing weakness in the limbs, the patient is no longer able to walk, not even to stand. In many, great excitement manifests itself; they run about aimlessly, run into the water or into the woods never to return. Should this excitement increase, they will rave and even become dangerous. In order to protect themselves, the relatives attach a slave-fork to the victim. This fork is a heavy tree mast, one end of which is shaped into a fork. It is placed around the patient's neck from the front and locked at the back. Thus the patient is compelled to drag this heavy log, which impedes any sudden or violent movement. For more security he is led by bast ropes. At the time of slave markets, the slaves were conveyed to the coast in this manner.

As soon as the natives found out that we possessed the cure for this dangerous disease, they came to us in masses, and annoyed us to such an extent that our camping place had to be fenced in. Each sick native was placed on the list, and received a number, which was written on a small wooden sign, and which he carried about with him. Only in this manner was it possible to maintain control and observation of the patients. At times we had as many as a thousand patients. In order to accommodate so large a number of people, it was necessary to build huts. There were no difficulties regarding this; in three days we built seventy-five huts, a place for hundreds of patients and their attendants. And as this did not suffice, a large shed was erected of the simplest material. People, who could hardly stand on their legs, supported themselves on a stick, which is not usually carried, so that one could take this stick as the symbol of the disease. Where the stick was no longer sufficient, they were brought leaning on their relatives. The dangerously sick were carried in nets or hammocks. Among these were a number of people who were already in stupor. Such a patient sleeps but not continuously; if he is called by name, he will answer, but if left to himself, he will immediately fall asleep again. The disease is absolutely fatal. Not one case is known, in which the patient recovered unaided. Whole villages have died out; the last inhabitants have fled. In such abandoned villages only a few crumbling huts could be seen, and the neglected banana plantations gave evidence that the inhabitants were gone a long time.

Thus matters stood. Now fortunately we are in possession of a remedy with which this dangerous sickness can be cured. The remedy is atoxyl. With this not only mild cases, but even old and stubborn cases may be cured; however, the majority of the seriously ill still perish. My further task, therefore, consisted in researches into the origin of the Glossina palpalis along the German coast of the Victoria Nyanza. It proved that Bukoba was free from it, while it was present in Shirati on the east coast, near the English border, as well as in Muansa on the south coast. Bukoba is not endangered, for two facts are necessary: first, the presence of the disease-producing trypanosomæ; second, the presence of the fly, which absorbs the trypanosomæ from the sick and inoculates the well. Such sick have undoubtedly already come to Bukoba, but the other factor—the fly—is absent, and for that reason Bukoba cannot be converted into a plague center of sleeping sickness. In Shirati, on the contrary, infections have already occurred, after the infected gum-gatherers brought the sickness. In Muansa, too, infections have occurred, and this place is especially in danger on account of the unfavorable hygienic conditions. Muansa is preferred agriculturally; it is the most beautiful spot on the entire lake, and, at the same time, the most frequented of all the harbors. From the hygienic viewpoint, however, it is far behind all the places of commerce on the Victoria Nyanza. Malaria, dysentery and acarus fever, and, among the cattle the coast-fever rage here. All these diseases and plagues can be suppressed, as their causes are known and can be uprooted. In Muansa the homes of the Europeans stand amidst the huts of the natives. This is a grave error; for in this way the Europeans despite all precaution and hygiene, which they bestow upon their own dwelling places, are exposed to the same danger as the natives. It is, therefore, necessary that care should be exercised, that the European settlements be widely separated from the dwellings of the natives. Secondly it should be made impossible for the natives to pollute the water. They wash their soiled clothes in the brook, which runs through the place, or on the lake shore; at the same time, however, they bathe in this water and use it for drinking. Water puddles, breeding places of malaria, are to be found everywhere, and in the brook also the mosquitoes thrive excellently. Here help must be brought about through the removal of the sloughs and the regulation of the brook, if the fever is to be stopped. In order to suppress the relapsing fever, the acaræ must be exterminated. These do not live merely in the huts of the natives, but penetrate the houses of the Europeans, where they hide during the day in wall cracks and in small gaps and holes of the plaster. In these hiding places they must be searched for and exterminated. For the coast-fever of the cattle, nothing else can be done except isolation of the diseased herd. In order not to allow sleeping sickness to take hold, it is necessary to keep the glossinæ away from the vicinity of the Muansa, and this is only possible if along the lake coast a broad belt free from such vegetation which is necessary for the glossinæ is maintained. We cherish the hope that the present colonization administration will soon do everything possible to make a healthful Muansa from an unsanitary one.

Koch among his colleagues was a master, and among the natives a father. Having now called attention to his discoveries in Europe and Asia and Africa, let us attempt, howsoever incompletely, to gauge his stimulus to scientific progress.

III. HIS INFLUENCE

Ever since that memorable demonstration at Cohn's Institute, Koch was a factor in the development of medical science. When we consider the number of investigators, both friendly and antagonistic, he kept at their microscopes and laboratories; the amazing number of epoch-making discoveries for which he alone was responsible; the pupils he taught and the expeditions he led; when we remember that the methods he inaugurated, and the technique he perfected, have become an indispensable part of the curriculum of every medical student; when we reflect how inadequate was our knowledge of infectious diseases before he appeared, and how our concept has been broadened by his labors, we must realize that his influence in medicine was surpassed by no man of his century, and equaled only by Lister and Pasteur.

From a sentimental viewpoint it is deeply to be deplored that between the great Frenchman and the great German—

and their respective schools—there was lifelong and ill-concealed animosity. Pasteur and Koch were often at work on similar problems, but though both walked toward the same goal, they never arrived together.

After Pasteur and Koch, the outstanding figure in the annals of infectious diseases is Ehrlich. When age and illness were writing the last chapter of the life of Robert Koch, the career of Paul Ehrlich was at its zenith, and when the great biochemist followed Koch as a Nobel prizeman, he grew reminiscent, and drew a wonderful picture of his student days and illustrious teachers. His life was crowded with soul-stirring adventures in scientific discovery, but in speaking of the time Koch invited him to work in his laboratory, Ehrlich said: "This was perhaps the most interesting time of my life."

On Koch's sixtieth birthday, a Festschrift of over 700 pages was published in his honor, with contributions by forty pupils who had achieved eminence in science, among them being Gaffky, Pfeiffer, Uhlenhuth, Wernicke, von Esmarch, Kolle, Hueppe, Frankel, Flügge, Loeffler, Ehrlich and Wassermann.

Koch's pupils were not limited to his country or race, and perhaps no disciple gave him sincerer gratification than Kitasato, who brought Koch's technique to Japan, and by its application discovered the bacilli of tetanus and bubonic plague.

We have already told how Cohnheim was stirred to noble joy by Koch's methods. Among the students in Cohnheim's Pathologic Institute, was a young American who soon caught the flame of Cohnheim's enthusiasm. William Henry Welch, now so venerable but then in his twenties, absorbed the quintessence of the new science for his country. The day came when he studied under Koch himself, and returning to America became a pioneer of bacteriology and pathology in his native land, where he is now the revered dean of the profession.

Other Americans who crossed the Atlantic to serve as neophytes in Robert Koch's temples of science, and came back to spread the gospel of exactitude and experimentation, are Theophil Mitchell Prudden, of Columbia University; Victor Clarence Vaughan and Frederick George Novy, of the University of Michigan; Alexander Crever Abbott and Ernest Laplace, of the University of Pennsylvania; Harold Clarence Ernst, of Harvard; William Webber Ford, of Johns Hopkins; Richard Pearson Strong, of the University of the Philippines; Hermann Michael Biggs, of University and Bellevue Hospital Medical College. Thus, in each of these institutions, and in numerous others, the pupils of Koch, now grown into teachers in their turn, taught thousands of students the significance of the four postulates, showed them the poured-plate method, and made them stain bacilli—in the manner of the master.

In many of our scientific investigations, the hand of Koch was present. For example, in 1898, when typhoid bacilli proved far more deadly to the American soldiers than Spanish bullets, a committee was appointed to report on the origin and spread of typhoid fever in the military camps. The committee consisted of Walter Reed, Victor Clarence Vaughan and Edward Oram Shakespeare. Reed was a pupil of Koch's foremost American pupil, Welch, and both Vaughan and Shakespeare were among the pilgrims who journeyed to Koch's laboratories in Germany. The report, finally issued in two large volumes which definitely exposed the common fly as the arch-criminal in typhoid, is one of our epidemiological masterpieces, worthy of those who drew their inspiration from Robert Koch.

It was by no means necessary, however, to go to Germany to feel the influence of Koch. Edward Livingston Trudeau remained in the Adirondacks, and did not understand the German tongue, but whoever has read the Autobiography of this remarkable man, will remember how the work of Robert Koch hovered like a guiding star over Saranac.

Mention must be made of two other American scientists who never studied under Koch, and yet in a peculiar sense were his pupils—his nephew and his niece. Robert Koch's brother, Arnold, came to America in 1867, carrying letters of introduction from Alfred Nobel. He settled in St. Louis, and here were born his children Waldemar and Mathilde.

Waldemar Koch received his Ph.D. in organic chemistry from Harvard in 1900, when he was twenty-five years of age; after serving as assistant in physiology in the Harvard Medical School, he was appointed associate in physiological chemistry at the university of Chicago, in which institution he later became associate professor of pharmacology. Aided partly by a grant from the Rockefeller Institute, he was enabled to work—during his vacations—with Schmiedeberg in Strassburg, and Mott in London. He supplemented his chemical and physiological training by taking the laboratory and clinical courses in medicine, and was thus equipped to approach his subject from various roads.

Waldemar Koch made several valuable discoveries in cerebral chemistry, and by linking these investigations with his pharmacological researches he was brought face to face with that monster of a problem: How do drugs combine with nerve cells? The papers which he published brought him nearer and nearer the solution, and he seemed to be on the verge of epoch-making discoveries in the pharmacology of the nervous system. Great things were expected of Waldemar Koch, who appeared likely to become the foremost pharmacologist in America. Then came pneumonia, and Waldemar Koch lay dead among a hundred unfinished experiments.

Some aspects of his work have been carried on by his sister, Mathilde Koch, whose investigations on the chemistry of the central nervous system under normal and pathological conditions have been published in the Journal of Biological Chemistry, American Journal of Physiology, Hygienic Laboratory Bulletin, Journal of Comparative Neurology, and Archives of Neurology and Psychiatry. Some of her investigations have been conducted independently, and others in association with Waldemar Koch, Oscar Riddle, and Carl Voegtlin.

It is to Mathilde Koch that we are indebted for the portraits and other illustrations which grace this essay, and which now appear for the first time. To have been entrusted with these priceless heirlooms of Robert Koch, has made us feel like the guardian of a shrine. To have been chosen to present this hitherto unpublished material to the profession, is a privilege for which, as a student of medical history, we are profoundly grateful.

In the campaign against the invisible enemy, every physician uses ammunition from the arsenals of Koch. In the warfare of man versus microbe, we march to battle under the banner of Koch. He invaded continents, not for the conquest of his fellow-men, but to lead the warriors of science against plague and pestilence. He uncovered the source of anthrax and tuberculosis and cholera and Egyptian ophthalmia, and gained victories over typhoid and rinderpest and trypanosomiasis. In all the years to come, all who fight disease will follow in his steps. His services to the world in which we live are utterly incalculable. Whole empires have flourished and perished without contributing as much to the sum of human knowledge as that one man, Robert Koch.

(1845–1916)

ELIE METCHNIKOFF

I can see you now at the Budapest Congress in 1894, disputing with your antagonists; with your fiery face, sparkling eyes, and dishevelled hair, you looked like the Dæmon of Science, but your words, your irresistible arguments raised the applause of your audience. The new facts, which at first seemed to contradict the phagocyte theory, now entered into harmony with it.

EMILE ROUX.

Metchnikoff's researches, while they have illumined the whole pathology of infective diseases, have beautifully completed the theory of antiseptic treatment in surgery.

JOSEPH LISTER.

The frequent traveler by omnibus and tram routes to Sèvres, where Metchnikoff lived, would often see the greatest scientist in Europe sitting side by side with a red-cheeked peasant woman and instructing her gravely in the art of sterilizing salads.

CHARLES DAWBARN.

XXIX

ELIE METCHNIKOFF

The age of thirty is regarded as a critical period in a man's life, and we find that various noted individuals have celebrated this year in a characteristic manner: at thirty, Newton devised his reflecting telescope; at thirty, Napoleon invaded Egypt; at thirty, Humboldt observed the meteor-shower; at thirty, Helmholtz invented the ophthalmoscope; and Nicholas the First, characteristically enough, celebrated his thirtieth birthday by building a tall straight post, topped with a strong crossbar. To this gallows he invited all Russia that did not agree with him. After the hanging of the Dekabrists, opposition lost its voice.

In his childhood, Nicholas had an excellent teacher, but he refused to be educated, just as he refused to wear civilian costume. Throughout his reign, Russia was turned into a vast barracks under chronic martial law. The term of service was twenty-five years. The life was so hard that when a man was recruited, his relatives followed him as if to the grave. Nicholas, who was interested in nothing but the army, spent his time in reviewing troops and altering uniforms. If, on a hot day, an officer appeared on the streets with the hooks of his uncomfortable collar unfastened, he was liable to be degraded to the rank of common soldier and deported to some distant province. For the slightest infraction of the most insignificant rule, the soldier was condemned to run the gauntlet—an ordeal which often terminated the victim's existence.

During this reign originated the widespread system of stealing Jewish children from their homes, separating them from their families, severing them from their faith, and bringing them up in cantons, under General Arakcheev, chosen for this task because of his severity. Thus it came about that when a mother of Israel gave birth to a boy she did not rejoice as for one born and living, but lamented as for one dead and departed. The methods which Jewish parents adopted for saving their children from the army—such as cutting off their thumbs or taking out one of their eyes—forms one of the darkest chapters in the story of mankind.

Of gigantic stature and possessed of herculean strength, Nicholas the First with the coöperation of the secret police which he created, seemed omniscient. Over the head of every Russian dangled the knout, and no rebel arose to oppose this tyranny. During all the many years that Nicholas sat on his throne, no torch of revolt glimmered in the bloody gloom. Only an anonymous pamphlet cried out that the tsar had rolled a great stone before the door of the sepulcher of truth, that he had placed a strong guard round her tomb, and in the exultation of his heart had exclaimed, "For thee, no resurrection!"

So thoroughly was liberalism crushed, so completely was absolutism supreme, that Nicholas walked the streets of Russia unattended and unafraid. In those days, the mighty country had only knees to bend, but no hands to strike.

The character of Nicholas earned for him the epithet of the Iron Tsar, but it was obvious that his special antipathies were the Poles and Jews. Nicholas himself claimed that his hatred of these races was due to certain tales that were told him by his English nurse, Miss Lyon. Thus, two English nurses are intimately connected with Russian history: one, Miss Nightingale, mitigated human misery; and the other, Miss Lyon, increased it.

Nothing permeates quicker than race prejudice, and since the emperor himself set the pace, it is not surprising that his Imperial Guard soon became a hotbed of antisemitism. It has been found, however, that antisemitism, although virulent against the Jew, may be entirely innocuous against the Jewess. For example, the Jewish author and translator, Leo Nevahovitch, who was the first to publicly defend his co-religionists, and whose talent was such that one of his plays was performed before the previous tsar, nevertheless found it expedient to permit himself to be baptized into the Greek Orthodox Church. His attractive daughter, however, Emilia Lvovna Nevahovna, required no such immersion. Wherever she went, prejudice succumbed to admiration. At a ball, the poet Pushkin plainly hinted she was charming, and the officers of the Imperial Guard would gladly have adopted her as their mascot.

Among these officers was the handsome, fair-haired Ilia Ivanovitch, descendant of a Moldavian Boyar. A judge of horses, a connoisseur of food, and an expert in cards, Ilia Ivanovitch was among the gayest of his set, but when his blue eyes saw the dark-eyed Emilia, he was suddenly sobered. The young officer rose from his table long enough to woo Leo Nevahovitch's daughter, and they were married.

The fortune which Emilia brought her husband must have been considerable, for while he began spending it immediately, he did not reach bottom for some years. Ilia Ivanovitch again rose from his table, remembered his wife and children, and wondered what to do. Emilia urged that they leave the capital and retire to Ilia Ivanovitch's far-off estates among the steppes of Kharkoff. The jolly guardsman protested indignantly against this exile, but when a man's coffers are empty, he is peculiarly susceptible to reason. Ilia Ivanovitch finally bade the pleasures of St. Petersburg good-by, and started with his family for Passanovka. Amid the wormwood of this village, Emilia arranged for her husband a table that delighted every gambler in the district. For incredible periods, throughout the day and far into the night, Ilia Ivanovitch sat at his meals and cards. Numerous serfs performed all the work, tutors attended to the children, and there was nothing for Ilia Ivanovitch to do except to play and issue orders. His chief exertion consisted in buying horses which he transported to St. Petersburg, but every stage of his journey was eased by dissipation.

Shortly after his settlement in Passanovka, Ilia Ivanovitch again became a father, and announced that he desired no further honors in this line; yet, within two years—on the sixteenth of May 1845—he was presented with a fifth heir. Ilia Ivanovitch was annoyed, and wondered at the stupidity of nature which did not allow wives to perform their duties without inconvenient consequences. However, the offspring of Ilia Ivanovitch did not interfere seriously with his cards, for he saw his children only twice a day: once, when they came to kiss his hand in the morning; and once, when they came to kiss his hand in the evening.

Time passed, and Ilia Ivanovitch grew old and fat and bald, but still he shuffled his clubs, diamonds, hearts, and spades. Ilia Ivanovitch was not a bad man; he was simply true to the traditions of his class—the class of rotters. We may now dismiss him, and center our attention upon his younger son, for the unwelcome babe born that May morning, proved to be the ace of the pack—Elie Metchnikoff.

The child Metchnikoff was nervous and irritable, yet in spite of his uncertain health he was very much alive—his mobility earned him the name of Quicksilver—and he seems to have been a general nuisance. As his eyes were weak, his physician forbade lachrymal exercise, and the little boy soon discovered that if he announced he was going to cry, he could attain any of his objects. Thus began a series of petty tyrannies which exasperated the entire household, except, of course, his mother.

It was found that music would keep him quiet for hours; he did not take lessons on any instrument, as the elder children had long practiced in vain, and the parents decided the family lacked musical talent. Elie, however, might have learned to play, since his love for music remained one of the dominant characteristics of his life. At times his need for music was so imperative that he would attend a concert or opera even if final examinations occurred the next day. As he was unable to sing or perform, whenever his latent instincts demanded activation, he whistled—and he whistled very well.

As the response to music is almost universal, Elie's early passion aroused no surprise. It was in another respect that he showed himself different from his companions: a plant or insect which others passed by, completely fascinated him. At eight he was an ardent collector, and began to write compositions on botany and zoölogy. As far as we know, there was nothing in his ancestry, or in the cards-and-horses environment in which he was reared, that explains his predilection for science.

In spite of this gift, the dawn of Elie Metchnikoff's career was far from happy. Several of his greatest expectations ended in failure. When he was about fifteen or sixteen, he studied the Infusoria—with a borrowed microscope—and believing he had made a discovery, he sent an account of his findings to the Bulletin of the Moscow Society of Naturalists. His heart beat with the wild joy of first authorship when his manuscript was accepted, and he was impatient to see it in print; further research proved to him he had been mistaken, and he was forced to make frantic efforts to stop the publication of what would have been his maiden article.

At the age of seventeen, the impetuous Metchnikoff succeeded in convincing his mother—who in turn persuaded his father—that the Russian universities were backward in instruction and hopeless in laboratories. He wished to go to the University of Würzburg to study protoplasm under Professor Kölliker. Full of enthusiasm he started to cross the continent; finally, one evening his train brought him to Leipzig, the headquarters for books. He engaged a room, and the next morning hastened to amass a library. After procuring as many treasures as his purse would permit, he suddenly remembered he had forgotten to note the address of his lodgings. The difficulties he experienced in again finding his room made a lifelong impression upon him. He now proceeded to his journey's end, but at Würzburg a great disappointment awaited him. It was vacation-time in the academic circles of Germany: the entire faculty of Würzburg, including Kölliker, was absent, and would not return for several weeks. Learning that a group of Russian students was in town, Metchnikoff presented himself, but they would not receive him.

He then began to search for a room. Why is it that those who rent rooms are among the most unpleasant specimens of the human race? If anyone wants to know how obnoxious a landlady can be, let him read *The Story of My Life,* by J. Marion Sims. Metchnikoff found a room, but as he unpacked his bag, he could not go on. A terrible loneliness overpowered him and his one desire was to return home. When he informed the old couple from whom he rented the room of his intention, they heaped reproaches upon him, and it was to the chorus of their abuse that the bewildered boy left the university town which he had entered with such hopes. Not the University of Würzburg, but the University of Kharkoff was Elie Metchnikoff's alma mater. Had Kölliker not been away at that time, modern biology might have had a different history: at any rate, Metchnikoff lost an illustrious teacher, and Kölliker lost an unusual pupil.

At eighteen, Metchnikoff's memoir on the Vorticella appeared in Müller's Archiv, this being his first published article. He was not permitted to enjoy it long, for Professor Kühne attacked his views with unpardonable harshness.

The following year Metchnikoff managed to go to the magic island of Heligoland, where various celebrated naturalists were studying biology. Although Metchnikoff practically starved at this time, his zeal, youth, and ability won the favor of Ferdinand Julius Cohn, who advised him, in the course of their walks and talks, to work under Rudolph Leuckart at Giessen. Leuckart received him graciously, and when the celebrated zoölogist went on his holidays, the eager Metchnikoff remained alone in his laboratory. Upon Leuckart's return, Metchnikoff joyfully informed him that in his absence he had made a discovery—he had found that the hermaphroditic parasitic lungworm of the frog could produce free bisexual offspring. Leuckart, although one of the principal authorities on Nematodes, doubted the correctness of Metchnikoff's observations, and when the young man substantiated his statements, Leuckart proposed that they continue their researches in this line and publish a memoir together. The thought of having the name of Metchnikoff linked with that of Leuckart, filled the youth with happiness, and he worked until he overstrained his eyes. Leuckart told him to take a vacation, and Metchnikoff tarried a while at Geneva, and later passed through Heidelberg where the trinity of Helmholtz, Virchow and Bunsen drew a host of Russian worshippers. In the library, Metchnikoff turned over the scientific periodicals which had just come in, and pounced upon a copy of the Göttingen News, which contained a memoir on the Nematodes by Leuckart; in great excitement, he looked for his own name; to his consternation, he found only a passing reference to himself and that the elder man had annexed his discovery. It was Leuckart who proved that trichinosis in man is due to eating infected pork: he likewise offered a personal demonstration that an eminent scientist may be affected with swinish qualities. How different was his contemporary and countryman, Carl Ludwig, who would plan great researches, do nearly all the work himself, and then publish epoch-making monographs without his name, assigning the authorship to some pupil who had watched him!

Thus Metchnikoff was again wounded by life, but his scientific productivity must have been as a balm. For he remained away from Russia for three years, and these years were rich in zoölogical, anthropological and embryological work. Although he did not realize it at the time, the foundation of his researches was laid at this period. Upon returning to his native country in his early twenties, Metchnikoff brought a reputation with him, and was appointed professor of zoölogy in the University of Odessa. He did not possess sufficient diplomacy, however, to enjoy university life, and his academic career was marked by wordy storms and heartaches. A professor's chair could not compensate Metchnikoff for the lack of a laboratory.

Metchnikoff was human enough to imagine that marriage would soothe his nerves, and in his twenty-third year he announced his intention of marrying Ludmilla Fedorovitch. Metchnikoff had loved other women more passionately—including even a charming sister-in-law—and it is to be hoped that Miss Fedorovitch never saw the unromantic letters in which her betrothed wrote to his mother:

> Her love for me is beyond doubt. . . . I like Ludmilla and I feel comfortable with her. . . . She is not bad-looking, but that is all. She has fine hair; her complexion is not pretty. . . . She has faults, but what is to be done? . . . I have not yet found a vulgar trait in her character. . . . I intend to have no children, it is an embryologist who is speaking.

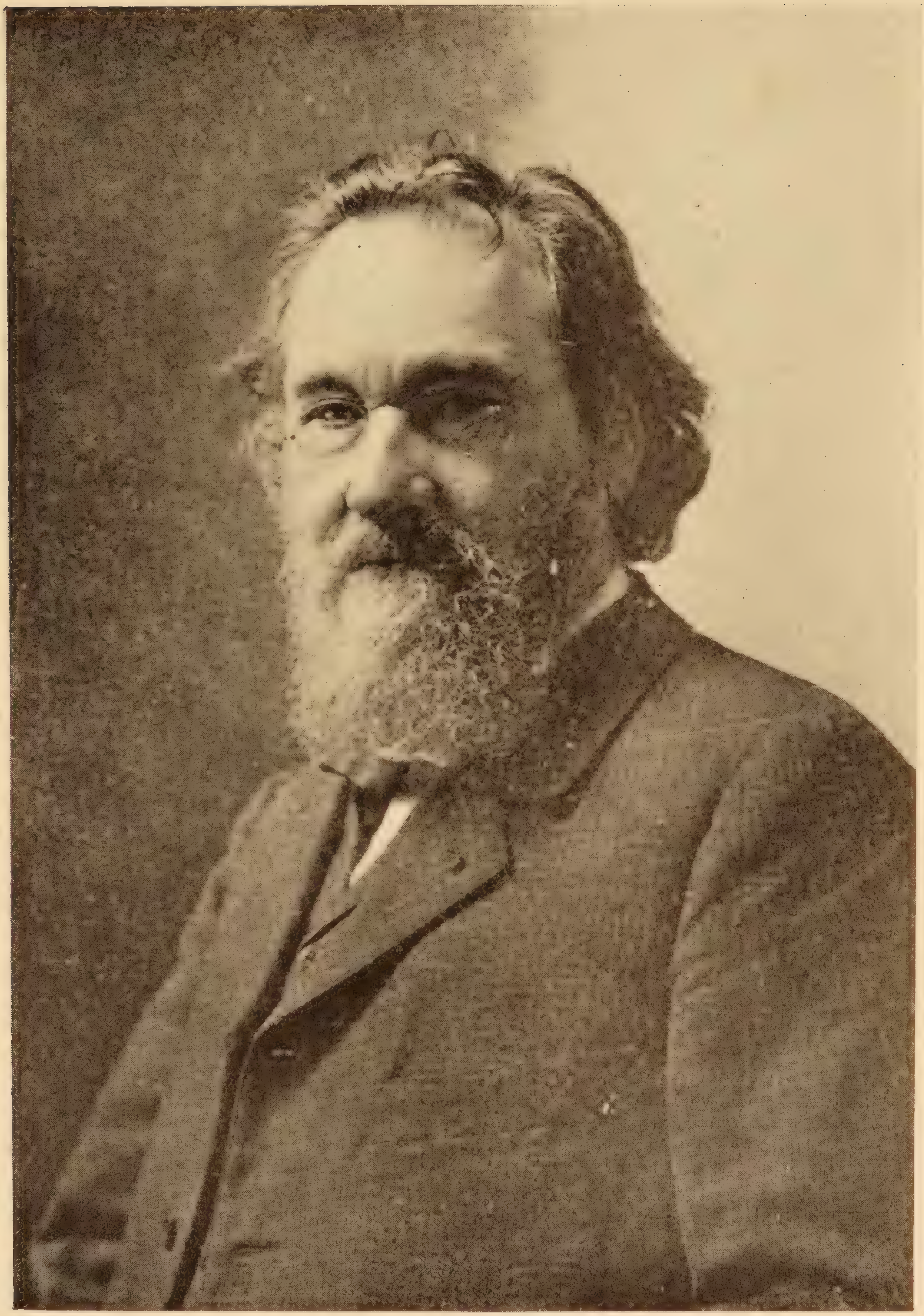
Metchnikoff was unhappy and needed sympathy: Ludmilla was devoted to him and had nursed him during an illness. In spite of his lukewarmness as a lover, nothing could break his resolution to make this girl his wife, although he soon perceived he would have an invalid on his hands. On the wedding-day Ludmilla was so weak that she was carried to church, for tuberculosis was a guest at that ceremony. Metchnikoff became a husband looking at the world through somber spectacles. However, a neurotic young Russian may be counted upon to do the most morbid thing possible.

As Metchnikoff's acquaintance with his wife increased, his affection for her developed, and after a few years he loved her tenderly. Only the tubercle bacillus marred their plans, and the young wife fought for health at Spezzia, Montreux, Villafranca, St. Vaast and Madeira. Amid the picturesque beauties of this archipelago—one of nature's masterpieces—Metchnikoff was strangely haunted with the phrase, "a flower-decked grave," and his fears were justified. While attending to his classes at Odessa, he was summoned to return to Madeira. Here he found a dying woman whom he hardly recognized; her desire to live was intense, but doom was written in her wide-open eyes. The tubercle bacillus had conquered.

Metchnikoff's health at this time was bad, his eyes especially causing him much anxiety. After his wife's death, an ominous calm seemed to possess him. He instructed the physician to make a post-mortem examination, and politely and firmly informed a Scotch minister, who offered him the comforts of religion, that he could not believe. He destroyed his papers, put a vial of morphine in his pocket, journeyed through Spain, then met his brother at Geneva. The crisis seemed past, and his friends felt that as soon as his eyes improved, he would continue his researches. But Metchnikoff no longer cared for life, and swallowed all his morphine; not having toxicological knowledge, he did not realize that an overdose produces emesis, and to his dismay he was vomited back into the world from which he tried to escape.

The young Metchnikoff was a full-fledged pessimist. He spoke continuously of the disharmonies of human nature, and claimed that to bring a child into life was an enormous wrong. It must be remembered that Metchnikoff lived in the shadow of the Romanoffs. Craving freedom and self-development, he was surrounded by an historic despotism that appeared unchangeable. All intellectual activity was regarded with suspicion, and suppressed with pitiless force. The Russian who took a pen in his hand, at the same time put his foot on the highway to Siberia. Ivan Federof was the first of Russian printers. In 1564 he cast the Slavonic characters. Being accused of heresy, he fled for his life. The Lithuanian magnates with whom he sought refuge, made him till the soil. Unhappy Federof said: "It was not my work to sow the grain, but to scatter through the earth food for the mind, nourishment for the souls of all mankind." He perished in Lemberg in extreme poverty. Woeful was his fate—symbolic of the sad destiny which was to befall every literary man in Knoutland.

Imagine the United States of America if Franklin had been murdered, if Irving had been knouted, if Emerson had been imprisoned, if Longfellow had been starved, if Whittier had been hanged, if Holmes had been flogged, if Thoreau had been shot, if Whitman had been poisoned, if Hawthorne had been chained with iron, if Lowell had been kept in a secret dungeon, if Motley had spent his life in a mine, if Parkman had been tortured, etc., etc., etc. Yet this is exactly what occurred in Metchnikoff's country. If we open a textbook on Russian literature, we read of Lomonosov, by far the greatest Russian of his age, whose life was broken by political persecution; of Novikoff, whom Catharine II sentenced to serve fifteen years in a secret cell in Schusselburg; of Labzin, who wrote against corruption, and consequently was forced to end his days in exile; of Radischeff—the first to point out the horrors of serfdom—who was imprisoned, deported, and died by suicide; of Pushkin, who was exiled to Kishinev at twenty, and later to Mikhailovskoye; of Ostrovsky, the father of the Russian drama, who was placed under police supervision as a suspect; of the Byronic Lermontov, who was banished to the Caucasus for writing a poem on the death of Pushkin; of the martyrs Ryleev, Odoevsky, Shevchenko, Griboyedov, Pisareff, Tchernishevsky; of the brilliant and poetic Polezhaev, who was sent to the barracks when a minor and died there from consumption; of the popular novelist Bestuzhev, who was exiled to Siberia and then sent to the Caucasus as a soldier; of the great Gogol, who suffered at the hands of the censorship; of Turgenev, who was arrested and exiled to his distant estates for writing a brief obituary notice of Gogol; of the high-strung Dostoyevsky, who for no reason at all was sentenced to death, brought to the gibbet, pardoned there, condemned to hard labor, imprisoned, exiled, deprived of literary work, tortured in innumerable ways for several years until he became a mental and physical wreck; of Plescheev, one of Russia's foremost poets, who was sent as a soldier to the Orenburg region, and endured persecution for years; of Mikhail Mikhailov, who was condemned to hard labor in Siberia where he soon died; of Levitov, who while a student was exiled to the far north, and later removed to Vologda where he was forced to live in complete isolation from everything intellectual; of Petropavlovsky, who was



METCHNIKOFF

early exiled to the Siberian government of Tobolsk, where he was kept many years and from which he was released only to die soon after from consumption; of Saltykoff (Schedrin), the chief of satirists, who was exiled for several years into a miserable provincial town; of Belinsky, the great critic, who when he lay on his death-bed, received visits from the state-police. We read of the persecution of Palm and Potyekhin, of the years that Melshin, Korolenko, Zasodimsky, Elpatievsky, etc, spent in exile. By this time a terrible truth dawns upon the startled mind. In Romanoff's Russia, scarcely one single writer of worth escaped imprisonment or banishment.

Upon the sensitive nature of Metchnikoff, these conditions produced a deep despondency. It was not necessary for Metchnikoff to read Stepniak or George Kennan to learn the terrors of tsarism. He knew for what causes men and women and children were whipped, sent to prison without trial, deported to salt-mines, chained to walls or wheel-barrows, struck with gendarmes' guns, ripped open with bayonets, and driven to insanity and suicide. This was the deliberate and systematic policy of the government, and those officials who were most notorious for their brutality, were most certain of promotion.

At the outset, the Nihilists were not politicals, and did not fight tsarism. Their object was to teach the alphabet, not to overthrow the dynasty. Their watchword was To the People, and they established schools. Enormous numbers of peasants flocked to them. The old sat on the benches with their grandchildren and did their best to learn. Teachers and the taught were enthused with the great idea. Leaders and the led were comrades. Although several were heirs to fortunes, they refused to accept any money from their parents. They lived exactly like the peasants, several in a room, ate black bread and dressed in boots and sheepskin. Many of the girls cropped their hair close and put on blue spectacles, so they might not be fair in the eyes of men, and to look peasant-like they rubbed their cheeks with grease and steeped their hands in brine.

At first these enthusiasts actually expected official encouragement, and it was only when the government condemned to a slow death everyone who printed a leaflet, or distributed a booklet, or attended a meeting, or listened to a speaker, or joined a coöperative association, or started an experimental farm, that they commenced to oppose the Romanoff régime. It was only when the ultimatum, "No schools allowed!" was for several years rammed down their throats at the point of the bayonet that the Nihilists transformed their books into bombs. It was only when the prisons overflowed with their young warm blood that Sophia Perovskaya waved the handkerchief that sent an emperor to his death.

The favorite books of the Russian revolutionists of this period were the writings of Büchner, Feuerbach, Buckle and Darwin. This is not at all strange when we recall that the majority of the original Nihilists were students of science, coming chiefly from the medical schools and the Technological Institute, while the midwifery classes of the Medico-Surgical Academy furnished the women propagandists. This fact was so well established that when Turgenev wrote his epoch-making novel, "Fathers and Sons," in which the term Nihilist was first introduced, he naturally made the hero a young doctor.

For years, Metchnikoff lived on the fringe of the revolutionary movement, and was intimate with some of its conspicuous leaders, especially with Michael Bakunin and Alexander Herzen. He might have been swept into its vortex, but when he questioned the possibility of a popular uprising against oppression, he was answered by eloquence instead of evidence. Metchnikoff held to the thesis of Buckle, that chiefly by the progress of science can humanity advance. At the time when Peter Kropotkin threw down his geologist's chisel and raised instead the torch, thus choosing revolution instead of science as his lifework, Metchnikoff made the opposite choice, though as deeply as the Anarchist Prince he deplored that in his country liberty was wrapped in her winding-sheet while tyranny was robed in ermine.

During his widowerhood, Metchnikoff continued his lectures at the University of Odessa. He did not possess the serenity which we usually associate with a scientist. He was highly irritable, and noise drove him into a frenzy. To his despair, he found himself living under a family, which aside from the adults, consisted of eight children who were fed on mince-meat. During a sojourn in Naples, Metchnikoff was so annoyed by Neapolitan harmony of the nocturnal variety, that one night he poured a bucket of water over the heads of the serenaders. Imagine then his exasperation at being aroused every morning by the sound of finely chopped meat for eight children! At last he could endure it no longer, and came upstairs to complain.

One of the children, Olga, has told that she was seated at the tea-table with her schoolbooks, and upon the stranger's entry she hurriedly left the room, and did not even have time to distinguish Metchnikoff's features, but was struck by his paleness. Shortly afterwards, Metchnikoff learned that Olga was interested in natural history, and he offered to teach her. Olga was delighted, and Metchnikoff obtained her parents' permission for the lessons. After a few lessons, however, Metchnikoff again went upstairs, this time to obtain her parents' consent to marry her. Although Professor Metchnikoff was not yet thirty, he appeared a veteran savant in the eyes of the frightened and flattered schoolgirl. Olga has thus described her reaction to Metchnikoff's proposal:

> I had not suspected my Professor's feelings towards me, and was deeply moved when I was told of them; it seemed to me impossible to understand that this superior, this learned man could wish to marry a little girl like myself! I thought with terror that he must be mistaken about me; I felt as if I were going up for an examination without any previous study. However, I had a great affection and admiration for Elie; I was attracted by his whole personality, which produced a strong impression upon others as well as upon myself. . . .
>
> Moreover, my young imagination was impressed by his sad history and by his interesting appearance, at that time not unlike a

figure of Christ; his pale face was illumined by the light in his kindly eyes, which at times looked absolutely inspired. My whole heart went out to him, but I was not yet ripe for matrimony and was somewhat thrown off my balance by the unexpectedness of the event.

Metchnikoff's persistence overcame all indecision, and the date for the marriage was set for February 1875; a few hours before the solemn occasion, Olga's brothers appeared with a hand-sled, offering her a last ride, for "this evening you will be a grown-up lady and you can't play with us any more." When her mother found her thus employed, she warned her it was time to dress and do her hair. Olga's wedding-dress was the first long dress she had ever worn. After the ceremony, Metchnikoff wrapped her in a long warm cloak, and drove her to her new home.

Very early the next morning the professor found his child-wife busily engaged—in zoölogical exercises. Thus began a pedagogical-matrimonial experiment which lasted forty-one years, and which, in spite of early spasms of misunderstanding, ranks among the most successful of marriages. From the beginning they shared everything; Olga Metchnikoff's biological training enabled her to appreciate her husband's work—he had the felicity of quoting some of her researches—and her *Life of Elie Metchnikoff* is an admirable production, replete with introspection, and thick with Russian atmosphere. We are indebted to this book for many facts, and it will always remain the standard biography of one of the most interesting personalities of our day.

A happy marriage, however, could not calm the tempests in Metchnikoff's soul. Life and the Russian Government proved too much for his sensitive nature, and at about the time of the assassination of Alexander II, when "Punish everyone!" became the slogan of officialdom, Metchnikoff resigned from the University of Odessa, and attempted to end his life by inoculating himself with relapsing fever.

Once more he recovered, and in the autumn of the following year Metchnikoff went to Messina, taking with him his wife and her five brothers and sisters. One day some clever apes arrived in town, and Madame Metchnikoff and all the children went to the circus. Metchnikoff has told how he remained alone with his microscope, watching the moving cells of a transparent star-fish larva. The idea flashed across his brain that the mobilization of such cells might serve in the defense of the organism against the invaders of the body. Feeling himself on the trail of a great discovery, an intense excitement possessed Elie Metchnikoff. He began by striding up and down the room, but finally rushed to the seashore to collect his thoughts. In the Sicilian garden which he rented, grew a small tangerine tree which had been arranged as a Christmas tree for the children. Taking a few rose thorns from it, he introduced them within the skin of the star-fish larvæ, and found that in spite of the larva's lack of vascular and nervous systems, its mesodermic cells accumulated around the intruding thorns, just as the white blood cells of man surround a splinter or germ that enters the body. Thus was born the theory of phagocytosis—the doctrine that when microbes or other deleterious substances attack the body, an army of phagocytes rush to the injured part, hurl themselves upon the enemy, attempting to engulf and devour the invaders. While his family was away at the circus, Metchnikoff had climbed to immortality. Upon their return, the children spoke of the wonderful tricks of the performing apes, and no one knew of the revolution which had taken place in Metchnikoff's life. His career as a zoölogist was over: he was transformed into a pathologist, and although he had no medical training, he became a leader in humanity's warfare against infectious diseases.

In this eternal struggle between man and microbe, the name of Metchnikoff was to be linked with Pasteur. In the mid-eighties, Pasteur discovered the preventive treatment of hydrophobia, and a group of Russian mujiks who had been terribly bitten by a mad wolf, traveled from Smolensk to Paris to receive the magic vaccine. The physical condition of these peasants was such that a return journey was not expected; it was remarked that the only word in French they knew was "Pasteur," but this word was the Open Sesame to the door of healing. To the amazement of Russia, out of the nineteen peasants who started on their desperate pilgrimage, sixteen came back in perfect health. In order to apply the Pasteurian methods of preventive inoculation, Odessa established a Bacteriological Institute, and Metchnikoff was appointed its Scientific Director.

But just as many a French physician flung his M.D. into the face of Pasteur, telling him to earn a medical degree before he presumed to teach doctors, so various members of the medical fraternity of Russia balked at being under the direction of a layman like Metchnikoff. Disputes developed, opposition increased, and to use Metchnikoff's own phrase, he was enveloped by "obstacles from above, from below, and from all sides." Metchnikoff felt he must leave the Odessa Bacteriological Institute. In the meantime a terrible accident occurred: Pasteur had saved countless cattle from the dreaded anthrax; the physicians of the Odessa Bacteriological Institute attempted to imitate Pasteur's technique, with the result that instead of saving, they killed many thousand sheep. Metchnikoff could endure no more. The immovable heel of the autocracy, the prevailing inertia around him, the impossibility of changing anything, were gradually forcing him out of Russia. The peasants of Smolensk, mangled by a rabid wolf, had turned for relief to Pasteur, and now a more gifted Russian, wounded by the fangs of life, appealed to the same source. Metchnikoff asked Pasteur to permit him to work in his laboratory.

Duclaux concludes his narrative of the history of Pasteur's mind with the explanation that "the great scientist was conscious of not having laid hold of the vital point of the mechanism of the resistance of the organism, and it is perhaps for that reason that when Pasteur heard of the researches of Metchnikoff on phagocytosis, he gave immediate attention to them. It is his letter, inserted in the first number of the Annales de l'Institut Pasteur, which first pointed out to the French public the researches of M. Metchnikoff." Duclaux further says that Metchnikoff's conception of the leukocytes as the defenders of the body, constantly in circulation, always ready to throw themselves upon everything foreign appearing there, surrounding the cells of microbes, digesting them and making them disappear, or being themselves destroyed by the toxic secretions of the enemy, captivated the mind of Pasteur. Recognizing that phagocytosis was a key which unlocked many of the mysteries of immunity, the master felt that Metchnikoff belonged in his laboratory, and he welcomed the distracted Russian.

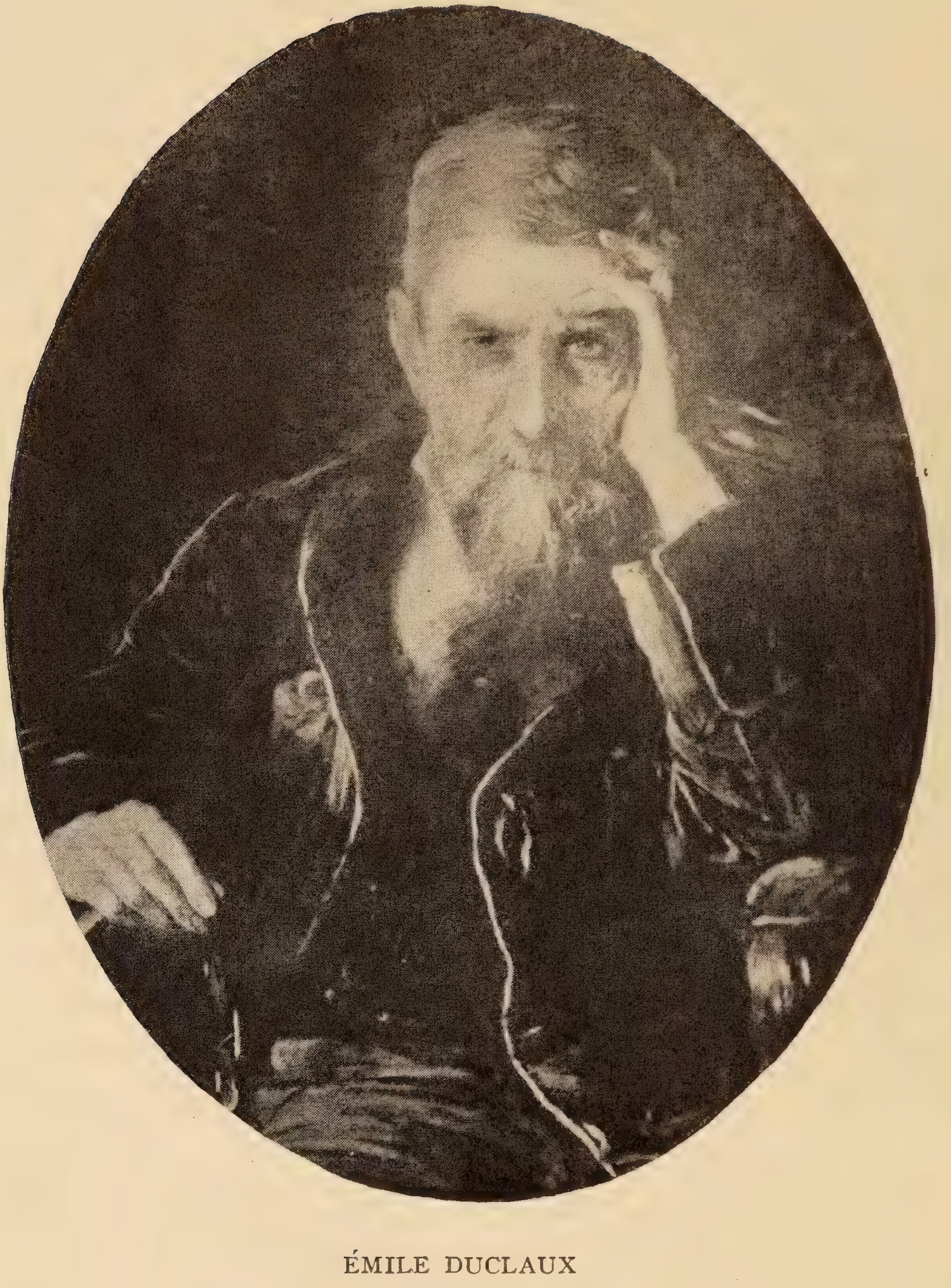
Metchnikoff arrived in Paris on the fifteenth of October, 1888. He was now in his forty-fourth year, and it remained to be seen whether he could adjust himself to the changed conditions. This outspoken fiery half-breed, a liberal in politics and an atheist in religion, could not easily conform to society's code. Metchnikoff entered the Pasteur Institute a misfit, but through the open door he carried with him an immortal discovery.

Immediately a new life dawned for Elie Metchnikoff. He never again lived in Russia. This exile, who could not feel at home in his native country, found a haven in the Rue Dutot. In those days the Pasteur Institute was as a monastery of science, and the Pasteurians formed a brotherhood devoted to investigation. Thus Metchnikoff came in contact, not only with Pasteur, but with Roux, Duclaux, Laveran, Chantemesse, Calmette, Pottevin, and others. At first a small laboratory was placed at Metchnikoff's disposal, and his wife served as his assistant; physicians overflowed this limited space, and an entire floor was given to him for his numerous pupils. Two rooms were set aside for his personal use, and Metchnikoff never gave up those rooms.

This middle-aged man now worked with an ardor which made him, next to Pasteur himself, the best-known of the Pasteurians. For several years, Metchnikoff was the most famous medical man in France, although he was neither a physican nor a Frenchman. At last Metchnikoff realized his dream of being able to seclude himself in his laboratory for days at a time: nothing that happened in the world outside could be as interesting as what he saw on a glass-slide. What was the launching of a warship or the fall of a dynasty compared to the battle of the cells? Not from the churches, but from the laboratories come the truths for the welfare of mankind. Metchnikoff's phagocytic theory, expanded by Almroth Wright into vaccinotherapy, has saved, and will continue to save, human multitudes.

Metchnikoff's life at the Pasteur Institute was filled with incessant activity. When Metchnikoff first discovered the phagocytic power of the wandering leukocytes, Virchow and Nikolas Kleinenberg were at Messina, and both of these eminent scientists accepted his conclusions: Kleinenberg called his conception "an Hippocratic thought," and Virchow published Metchnikoff's researches in his Archiv. The leaders of medical progress of other nations, Pasteur and Lister, at once supported the new idea, but opposition soon developed. Baumgarten cast the first stone, and Koch—who should have known better—and Behring and Pfeiffer attacked the new doctrine with doubts and demonstrations. The controversial literature of phagocytosis is enormous.

It was beautiful to watch with what fertility and ingenuity, with what enthusiasm and inexhaustible energy, Metchnikoff answered every series of objections with additional researches from fresh angles. At times his doctrine seemed seriously threatened, but after sleepless nights and further experiments, Metchnikoff came forward with additional proof. For twenty-five years Metchnikoff fought for phagocytosis, and to-day the consensus of opinion is in accord with that of the two great Britishers—Lord Lister and Sir Ray Lankester. In a presidential address, Lister said, "If ever there has been a romantic chapter in the history of pathology, it is the story of phagocytosis," while Lankester wrote: "The recognition of the va-



ÉMILE DUCLAUX

EMILE ROUX

lidity of the doctrine of phagocytosis in relation to wounds, disease, immunity, and normal healthy life is the triumphant result of the scientific insight and boundless energy of Elie Metchnikoff."

Aside from his chief thesis, Metchnikoff was immersed in a host of other researches, including his celebrated attack on the colon. His contention that intestinal putrefaction is the cause of senility, which could be combated by the beneficent germs of lactic acid, aroused world-wide attention, and made the fortunes of various manufacturers of lacto-bacilli. His views created a cult, and thousands of devotees throughout the world, headed by Metchnikoff himself, never passed a day without partaking of sour milk. Whether Metchnikoff's hypothesis concerning the prolongation of life will be substantiated by more conclusive researches, it is impossible to say, but it is certain that his efforts to fight the microbe of old age with the bacillus of long life, is typically Metchnikovian.

We have already narrated the adolescent Metchnikoff's search for Kölliker which terminated in disaster, and yet this journey was not wholly a failure, for in Leipzig Metchnikoff bought a copy of Darwin's Origin of Species, and upon reading it became a confirmed evolutionist. It was reserved for his latter years, however, to bring forward a striking proof of the Darwinian theory. Metchnikoff, working in collaboration with Roux, was the first investigator who definitely succeeded in inoculating anthropoid apes with syphilis. As man and monkey are the only animals capable of being infected with this disease, a blood-relationship is thus established between them. Before this time, 1903, physicians could study experimental syphilis only upon heroic volunteers—often themselves—or upon unsuspecting hospital-patients. The chapter dealing with the purposeful inoculation of human beings with venereal disease for scientific investigation, is one of the most mysterious and carefully-guarded in the annals of medicine. It was Metchnikoff also, again in conjunction with his friend Roux, who devised calomel ointment as a protection against syphilis.

Thousands of homes, where perhaps the name of Metchnikoff has never been mentioned, have been saved from venereal disease by the use of his prophylactic.

If we look through the collected essays which comprise Metchnikoff's *Forty Years in Search of a Rational Concept of Life,* we observe an interesting metamorphosis: the chapters written in early life are pessimistic, while the productions of his aging years are optimistic. Add to this his volumes on the *Nature of Man—Studies in Optimistic Philosophy,* and the *Prolongation of Life—Optimistic Studies,* and we find that the youthful champion of pessimism has become the apostle of optimism. The young man who twice attempted suicide became famous for his efforts to prolong the lives of others. It was his discovery of phagocytosis, "the curative forces of the organism," as he termed it, which first showed him the brighter side of life, and his happy activity at the Pasteur Institute completed the transition.

Numerous honors came to Mechnikoff, the greatest of them being that when he delivered a course of lectures on inflammation, among the audience sat Louis Pasteur. In the year of Pasteur's jubilee, Metchnikoff's work on the *Comparative Pathology of Inflammation* was published at Paris. After Pasteur's death, Metchnikoff was the chief attraction of the House. The University of Cambridge gave him an honorary D.Sc., and published his most important book, *Immunity in Infectious Diseases,* which he dedicated to the two Emiles of the House—Duclaux and Roux. In 1908, Metchnikoff and Ehrlich shared the Nobel prize in medicine. Metchnikoff came from a short-lived family, and he was a surprised man when his seventieth birthday was celebrated at the Pasteur Institute: in a wonderful jubilee speech, Roux testified to the love and esteem they all felt for Metchnikoff.

In manners and appearance, Metchnikoff was typically Slavonic. His hair was long, and when his experiments were interesting, his beard was neglected. Irrespective of the weather, he appeared with goloshes, an umbrella, and an overcoat bursting with pamphlets. He always wore the same hat, and when excited or absent-minded—which was often—he sat upon it. In spite of uncontrollable outbursts of temper, his kindness was proverbial. The goodness of Elie Metchnikoff matched his genius.

In the early summer of 1914, the Metchnikoffs spent their holidays in a little villa, quietly enjoying the peace of nature. Metchnikoff had developed myocarditis, and he would have been fortunate if during that July his life had suddenly ended among the ripening corn of St. Leger-en-Yvelines. He would not then have lived to learn that humanity was betrayed. Olga Metchnikoff has testified that her husband could not believe that war had been declared. He who had spent half a century in the service of Science, could not imagine that the forces of evil had conquered the world. There was no reason for the war, except that men wished to satisfy their ancient instinct to kill each other. The blood-lust of the ages burst forth: Mother Earth, mad with hatred, was murdering her children by the million.

Metchnikoff hastened to return to the House where Pasteur reposed, the sanctuary of science, where militarism could not intrude. A rude shock awaited him. As he approached the Pasteur Institute, no eager disciples crowded around their chief as in former days. A soldier's bayonet was across its portico, and the laboratories were deserted.

Then indeed the heart of Metchnikoff was broken, not from any cardiological complaint, but by the savagery of his fellowmen. This fighter for a rational life passed his concluding days in the abyss of insane butchery. As the war went on, he heard that one after the other of his pupils—young men who had worked under him and whom he expected to carry forward his work—had been slain on the battlefield.

At this time, while nation foamed against nation with rage, Metchnikoff preserved his international mind. Sitting in the midst of the collapse of civilization, Metchnikoff wrote in his native tongue his last memoir: *The Founders of Modern Medi-*

cine—Pasteur, Lister, Koch. In order to inspire young men who were seeking a scope for activity, Metchnikoff, the great Russian, wrote of the great Frenchman, the great Englishman, and the great German who had reared the foundations of scientific medicine. "It is to be hoped," he said, "that this unexampled butchery will, for a long time, do away with desire for fighting, and that soon the need will be felt of a more rational activity. Let those who have preserved the combative instinct direct it towards a struggle, not against human beings, but against the innumerable microbes, visible or invisible, which threaten us on all sides and prevent us from accomplishing the normal and complete cycle of our existence."

Soon afterwards, Elie Metchnikoff lay mortally ill, and only pantopon could bring him relief. The noble Roux, with the delicacy that always characterized him, suggested that Metchnikoff be transferred to Pasteur's old flat. Metchnikoff was deeply touched. Dying in the rooms of Pasteur, Metchnikoff felt himself on holy ground. When the end came, Metchnikoff, wrapped in a white sheet, was given to the flames. Within an hour, a handful of ashes was all that remained of Elie Metchnikoff, and these ashes, enshrined within an urn, were placed in the library of the Pasteur Institute which Metchnikoff had loved so greatly during life, and which he was not to leave even after death.

Peace to these ashes! When animate, they formed the man Metchnikoff—who saw clearly the disharmonies of life, and pointed out that only Science is capable of showing humanity the true path. Science in the service of all mankind; Science liberating the human race from the darkness of theology and the bondage of militarism; Science banishing the poison of patriotism by the antidote of international brotherhood; Science battling against the virulent germs which attack us and our beloved ones; Science prolonging the life of humanity, and making the increased span richer and better and happier—such was Elie Metchnikoff's legacy to his generation and posterity.

(1849–   )

IVAN PETROVICH PAVLOFF

I am also able to demonstrate to you the following instructive experiment. In the presence of some of my hearers, who were invited to attend an hour before the lecture, I carried out the following procedures on two dogs, both of which had ordinary gastric fistulæ and were, besides, esophagotomized. Into the stomach of the one a definite number of pieces of flesh were introduced through the fistula, the animal's attention being distracted by patting and speaking so as to avoid arousing any thoughts of feeding. The morsels were threaded on a string, the free end of which was fastened into the mouth of the fistular cannula by a cork. The dog was then brought into a separate room and left by itself. A like number of pieces were introduced into the stomach of the other dog in the same way, but during the process a fictitious meal was given, the animal being afterwards left alone. Each dog received 100 grams of flesh. An hour and a half elapsed, and now we may draw the pieces of flesh out by means of the thread and weigh them. The loss of weight, and consequently the amount of flesh digested, is very different in the two cases. In that of the dog without sham feeding, the loss of weight amounts to merely 6 grams, while the flesh withdrawn from the stomach of the other dog weighs only 70 grams, that is to say, was reduced by 30 grams. This, therefore, represents the digestive value of the passage of food through the mouth, the value of a desire for food, the value of an appetite.

PAVLOFF: *The Work of the Digestive Glands.*

XXX

IVAN PETROVICH PAVLOFF

In 1911, when the American Chemical Society met at Washington, under the presidency of Alexander Smith, few of the members expected to hear an address on a Russian physical chemist of the eighteenth century. They were hardly prepared for the information that from a fisherman's family, in a village near the North Sea, had come a child who passed his manhood in the dark Stahlian days when chemistry was befogged by phlogiston—and yet clearly saw the light before Lavoisier. This extraordinary individual was Michael Wassiliewitsch Lomonosoff (1711–65)—poet, grammarian, man of affairs, geologist, astronomer, mineralogist, meteorologist, metallurgist, and chemist.

Lomonosoff's chemical work was truly remarkable. But brilliant as the speculations were, they were not only speculations; they were substantiated by experiments, and not qualitative experiments only, but by quantitative, and not occasional quantitative experiments, but quantitative experiments regularly and systematically performed in his laboratory.

He was usually hot-headed and violent, and frequently poverty-stricken and drunk, but he had the brain of a nineteenth-century chemist. In his various chemical treatises, such as *Heat and Cold, Elements of Mathematical Chemistry, On the Uses of Chemistry, Course in True Physical Chemistry,* Lomonosoff urged the value of mathematical methods in chemistry, and pleaded for the union of chemical and physical truths. The "phlogistic epidemic" had infected practically every chemist of the century—but Lomonosoff escaped the fatal contagion.

On the annals of science are written many other glorious Russian names: Von Baer, the greatest name in modern embryology; Metchnikoff, immortal for his discoveries in phagocytosis; Korsakoff, who described the psychosis of alcoholic polyneuritis; Cyon, after whom is named Cyon's nerve; Minin, whose ultra-violet therapy is known as the Minin light; Stanislav Stein, whose test for disease of the labyrinth is known as Stein's test; Schachowa, who described the histologic canals known as the spiral tubules of Schachowa; Wreden, who first called attention to the fact that there is gelatinous matter in the auditory meatus of stillborn children; Kovalevsky, who described the passage from the medullary tube into the archenteron; Leshaft, after whom is named Leshaft's space; Nikolai Eck, of fistula fame, whose method of abolishing the portal circulation gave physiologists the opportunity to learn the relation of the liver to metabolism; Kupressoff, who described the spinal center of the vesical sphincter; Bobroff, whose osteoplastic operation for spina bifida is known as Bobroff's operation; Koshevnikoff, whose description of a mild type of epilepsy is known as Koshevnikoff's disease; Darkshevitch, the neurologist after whom is named Darkshevitch's nucleus; Botkin, the eminent clinician; Struve, whose test for blood in the urine is known as Struve's test; Bechterev, after whom is named the nucleus which gives origin to the fibers of the median roots of the auditory nerve; Cherchevsky, whose description of ileus of nervous origin is known as Cherchevsky's disease; Gamaleia, the bacteriologist; Minkovski, who described congenital acholuric jaundice with splenomegaly and urobilinuria; Mendeleyeff, whose periodic law is one of the fundamentals of modern chemistry; Waldemar Kernig, whose test is tried whenever meningitis is suspected; Poehl, who described the test for detecting cholera bacilli; Nikolsky, after whom is named Nikolsky's sign; Nikiforoff, whose method of fixing blood-films is known as Nikiforoff's method; Rauchfuss, after whom is named Rauchfuss' triangle; Pirogoff, one of the greatest of military surgeons; Filatov, the pediatrist—

and a host of other competent investigators whose work is known wherever medical literature is read.

There has recently passed away a Russian scientist who achieved the foremost place in the modern physiology of digestion—Ivan Petrovich Pavloff. He was born in September 1849, and thirty years later was graduated from the Military-Medical Academy at Petrograd. He then entered the service of Botkin, a teacher who meant much to him; years later, at a meeting which the Society of Russian Physicians of Petrograd held in memory of Botkin, Pavloff the laboratory man eulogized the clinician:

> More than ten years have now fled since the death of S. P. Botkin, and yet his memory lives with us all. If he was anything he was a clinician who astonished us all by his rare gift of recognizing a disease, and of finding the best remedy for it. On the patients his personality produced a really magic influence; a word from him, or even the mere fact of his visit had an effect. How frequently have I heard it confessed by his clinical pupils, that the same prescriptions which had worked wonders in the hands of the master had been, in apparently identical cases, without effect in their own. One might, perhaps, suppose that the celebrated clinician would have been satisfied both inwardly and outwardly with such results. But his deeper understanding, unalloyed by these triumphs, always sought in the laboratory, by experiment upon animals, the key to the great puzzle: What is a sick man and how is he to be helped? Before my own eyes he has directed many of his pupils to the laboratory. And this great appreciation of the value of experiment by the clinician, in my opinion, does no less honor to the name of S. P. Botkin than his clinical activity, which is known to all Russia.

In Germany, Pavloff studied under Ludwig and Rudolph Heidenhain. In 1890 he was appointed professor of pharmacology at Tomsk, but soon returned to Petrograd to take charge of the recently completed Institute for Experimental Medicine, and to accept the professorship of physiology at the

Military-Medical Academy, where he devoted himself chiefly to problems of digestion.

The earlier investigators of various nations had performed interesting experiments in digestion. On the title-page of a monograph on the pancreas, written in the seventeenth century by the young Hollander, Regner de Graaf, there is a picture of a dog with an artificial parotid and pancreatic fistula, and receptacles for collecting the secretions. In the middle of the eighteenth century, the French Réaumur published a treatise on the digestion of birds, relating that he introduced hollow metal tubes filled with pieces of sponge into the stomach of a kite; now it is a kite's commendable habit to vomit up indigestible articles, and when the tubes were expelled, Réaumur squeezed from the sponges an opalescent fluid, salty to the taste, and which turned blue litmus red—he was the first to obtain almost pure gastric juice.

The Italian Spallanzani experimented on many animals, including himself: to obtain human gastric juice he made himself vomit on an empty stomach; and he swallowed linen bags containing meat, which he later recovered and examined. He proved that gastric juice in a bottle dissolves food almost as well as in the stomach.

At the beginning of the nineteenth century, the American physiologist, John R. Young, in his graduating thesis, showed that the solvent power of the gastric juice was due to its acid principle, which he thought was phosphoric acid, but two decades later the British chemist, William Prout, demonstrated that the acid of the gastric juice is free hydrochloric. The work of the German chemists, Tiedemann and Gmelin, soon followed, containing among other discoveries the observation that the saliva contains a sulphocyanate.

Then a great accident came to the aid of physiology, for the Canadian half-breed, Alexis St. Martin—unscientific, illiterate, but immortal—was badly wounded by the discharge of a gun; half of his body was torn away, but the resistance of the woodsman was good, and he outlived his doctor by many years; when his wound healed, a gastric fistula remained, and on the wild island of Mackinaw, William Beaumont first saw the natural flow of gastric juice and studied the movements of the stomach in situ. Dr. Beaumont also reached the conclusion that the hydrochloric acid was not the only active chemical in the gastric secretion, and a few years later Theodor Schwann told him that this unknown substance was pepsin.

Later came the great work of Claude Bernard on the internal secretions and digestion, the researches of Willy Kühne, including his discovery of trypsin, and the feverish activity of the new science of physiological chemistry.

So we see that Pavloff was heir to much knowledge, and yet there was much to be learned. "With each advance in technique," said Pavloff, "we reach a higher level from which a wider field of vision is open to us, and from which we see events previously out of range." Pavloff accordingly proceeded to improve the technique of his predecessors.

When Pavloff began his labors it was not clearly known how the digestive juices were poured out upon the food, for to ascertain this, it was necessary to be able to obtain the juices at all times, collect them in pure condition, in accurately measurable quantities; it was further necessary that the digestive canal perform its functions normally, and that the animal under experiment be in perfect health.

The solution of these problems required more ingenuity than might be supposed. For instance, to collect pancreatic juice, all that seems necessary is to locate Wirsung's duct and affix a cannula. But the pancreas is a sensitive and capricious gland, and neither the temporary pancreatic fistula, nor the permanent one of Claude Bernard or of Ludwig's school, yielded satisfactory results. In 1879 Pavloff demonstrated a means of access to the gland lumen which settled that difficulty, but we will not quote his method, for we have learnt that medical readers skip surgical technique as readily as feminine readers skip descriptions of scenery in a novel.

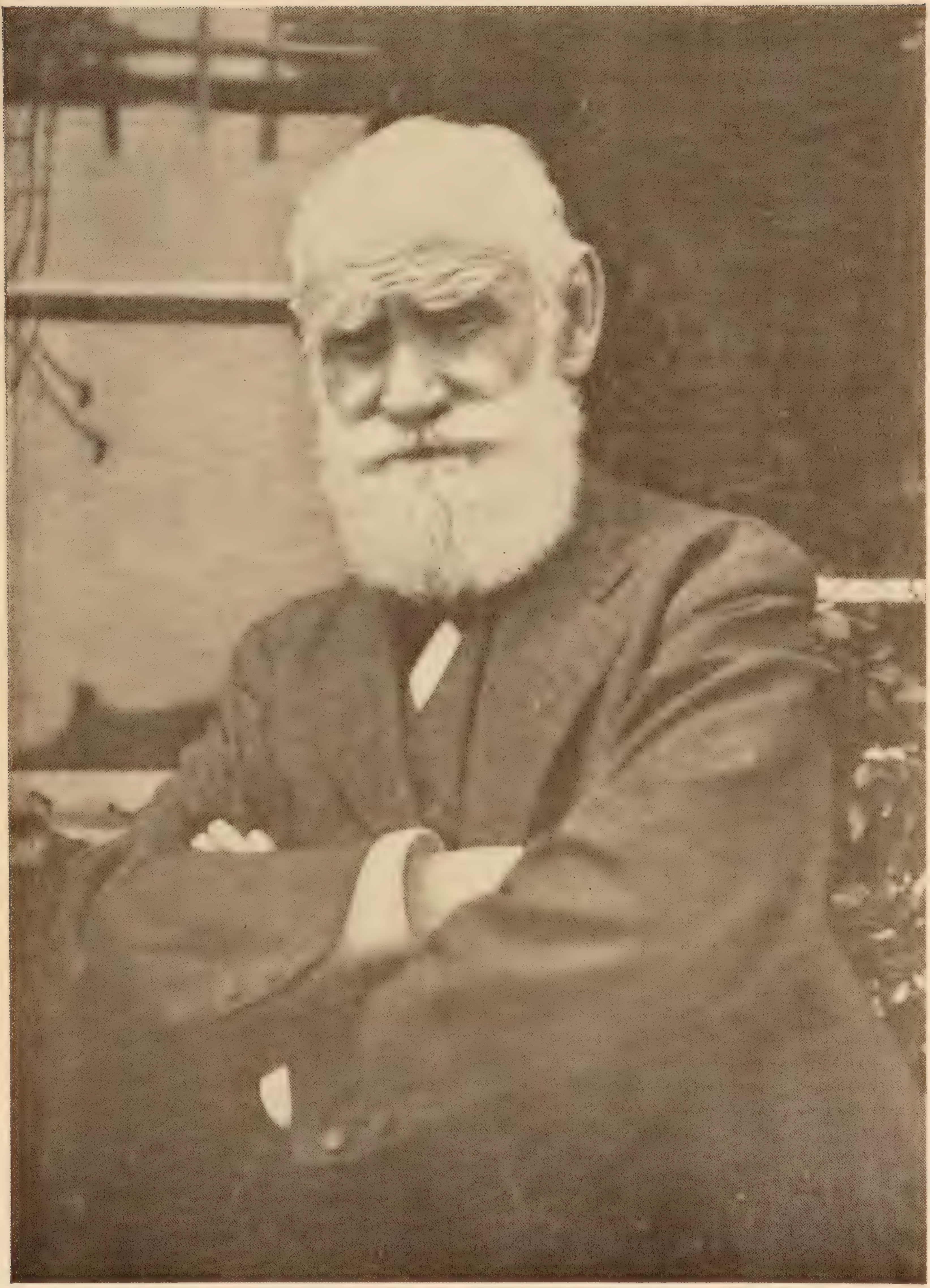
Pavloff's improvements were welcomed by all who were grappling with the mysteries of digestion. As Abderhalden wrote in the first edition of his *Text-Book of Physiological Chemistry:*

> We are now able to obtain the digestive fluids in purest form, thanks to the excellent methods originated by Pavloff and his students. It is possible, on the one hand, to prepare a small special stomach, that is, a pouch obtained by tying up a part of the walls of the stomach so as to form a blind-sac, from which the pure gastric juice may be obtained without the least admixture of any food residues. On the other hand, we can obtain absolutely pure pancreatic juice, clear as water, by making a pancreatic fistula, that is, by grafting into the abdominal wall that part of the mucous membrane of the duodenum at which the pancreatic duct enters.

Emil Abderhalden's book is really an extended panegyric of the Russian physiologist.

It was Pavloff who taught us that each of the salivary glands responds best to a special stimulus; the submaxillary reacts readily when in contact with acids, but the parotid pours out its secretion when dry food is chewed. Watery food stimulates the salivary glands to a slight degree only, but solid food excites a copious flow. If pebbles are placed in a dog's mouth, they will be dropped without causing a flow of saliva, but if these same pebbles are crushed to a powder and then placed in the dog's month, the salivary secretion will be considerable. Pavloff demonstrated a similar adaptability in regard to the gastric glands, and it may be said that the idea of the adaptability of the organism was one of the key-notes of his work.

In 1889, Pavloff and Madam Schumova Simanovskaia esophagotomized a dog already possessing a gastric fistula, and from this and similar animals procured gastric juice almost as milk is obtained from a cow. Heidenhain had shown that a portion of the stomach could be cut off from the rest of the organ and be given an artificial opening upon the abdominal wall—but Heidenhain's animals did not thrive, for their nerves



PAVLOFF

Photograph by Julian Scott at Woods Hole. Courtesy of the Scientific Monthly.

had been injured. Pavloff improved upon his teacher, by isolating a portion of the stomach with blood and nerve supply intact, and thereafter many a dog carried Pavloff's miniature stomach within him.

Pavloff is especially famous for his work on the relation of the nervous system to the digestive glands, and in this connection we may quote the conclusive experiment, now historical, which is to be found in his lecture on *The Centrifugal Nerves of the Gastric Glands.* It illustrates his clear and practical method of presenting his subject:

> We have before us a dog possessing an ordinary gastric fistula with metallic cannula, and with esophagus divided as well, so that the mouth is cut off from all communication with the interior of the stomach. The latter has been washed out before the beginning of the lecture, and, as you see, not a single drop of fluid escapes from the fistula. I give the dog food. The animal eats greedily, but the whole of the food swallowed comes out again at the esophageal opening in the neck. After feeding in this way for five minutes, which for shortness we shall henceforth call "sham feeding" or "fictitious feeding," perfectly pure gastric juice makes its appearance at the fistula, the stream steadily increases, and now, five minutes after its commencement, we have 20 c.c. of juice. We may feed the dog as long as we wish, the secretion will flow at the same rate for one, two, or more hours. We have had dogs so greedy that they continued eating in this fashion for five or six hours, secreting a total of 700 c.c. of the purest gastric juice. The meaning of the experiment is clear. It is obvious that the effect of the feeding is transmitted by nervous channels to the gastric glands.

In the presence of his audience, Pavloff then severed the vagi in the neck in a manner that occasioned neither cardiac nor laryngeal distress, but when the dog was again offered food which it ate with increasing greed for several minutes, not a single drop of juice flowed from the stomach. He thus proved that the vagus supplies specific secretory fibers to the gastric glands.

These experiments in "psychical feeding" have influenced some of the acutest minds of our generation. "Since Pavloff and his pupils," writes Jacques Loeb in his *Mechanistic Conception of Life,* "have succeeded in causing the secretion of saliva in the dog by means of optic and acoustic signals, it no longer seems strange to us that what the philosopher terms an 'idea' is a process which can cause chemical changes in the body."

Conversely, Pavloff plainly showed that mere mechanical stimulation was ineffective to arouse the gastric glands to activity. In his lecture on *Psychic or Appetite-Juice* he said:

> I now repeat the experiment of mechanical excitation of the gastric mucous membrane before you in the well-known and traditional manner. Here is a dog with a gastric fistula on which a cervical esophagotomy has in addition been performed. I open the cannula: as you see, nothing flows from the stomach; it was washed out clean with water an hour ago. We take the renowned feather and also a stout glass rod. Folds of blotting-paper saturated with red and blue litmus are placed at hand. I now ask my assistant to continuously move the feather and glass-rod, alternately, in all possible directions within the stomach, changing from one to the other every five minutes. On removal from the cavity each is carefully dried with red and blue litmus paper. You have now all seen, gentlemen, that this procedure has been kept up for half an hour. From the fistular orifice not a single drop of juice has escaped, and moreover, the damp patches on all the pieces of red litmus paper I have handed to you have a distinct blue tinge, caused by the moisture of the alkaline mucous membrane. The blue litmus paper, however, has merely been made wet without altering its color. Consequently, with the most thorough mechanical stimulation of the whole cavity of the stomach, we have not been able to find a single spot having a decided acid reaction. Where, then, are the streams of pure gastric juice of which we read in text-books? What objection can be raised against the conclusiveness of this experiment? In my opinion only one: that we are dealing with a dog out of health, whose gastric glands from some possible cause are unable to react normally. This single objection can be set aside

before your eyes. After failing with the mechanical stimulation, we proceed forthwith to give the same animal a fictitious meal. The dog takes the food offered to it with keen appetite, and you see that exactly after five minutes from the beginning of the feeding, the first drops of juice appear from the stomach, followed by others faster and faster. I catch a couple of drops on the blue litmus paper, and you see that they produce bright red specks. After thirty minutes' sham feeding we have collected 150 c.c. of juice, which, even without filtering, looks as clear and transparent as water.

The biliary fistula had been frequently employed by physiologists, and they observed the bile flow out of the fistula into the gall-bladder, but it is obvious that little could be learnt from this procedure, for the bladder is only the reservoir of the bile, but when Pavloff placed the mouth of the bile-duct into the duodenum on the outside of the body, he enabled investigators, for the first time, to study the secretion of the bile under normal conditions. By this method Pavloff succeeded in showing that the amount of the bile flow depends upon the taking of food, and that a maximum secretion is caused by proteids, a lesser amount by fats, and a minimum flow by carbohydrates.

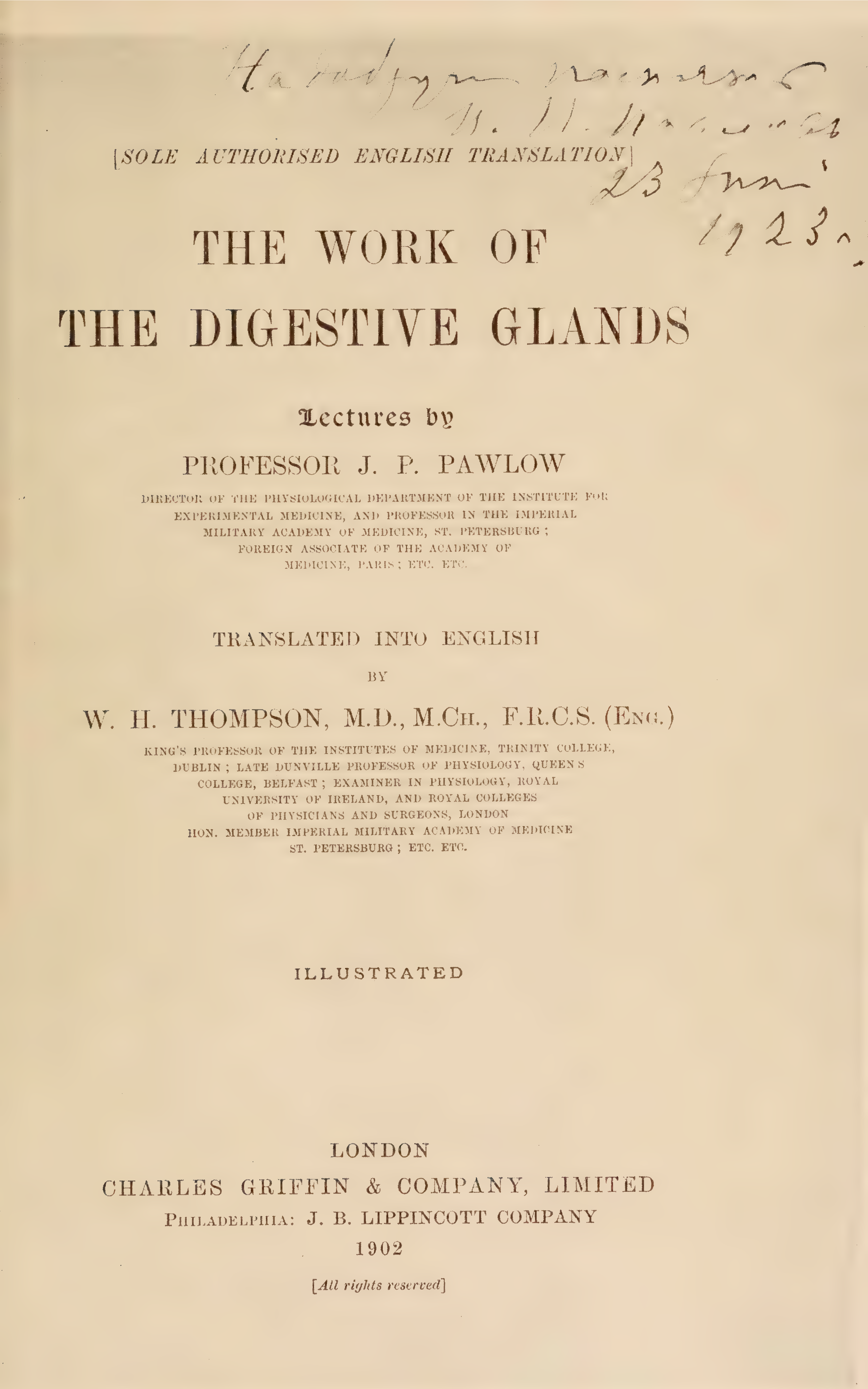
In the course of his researches in the pancreatic juice, Pavloff discovered an enzyme which was a "ferment of ferments," and he gave it the name by which it has since been known—enterokinase.

There are anti-vivisectionists in Russia, too, and Professor Pavloff—the arch-experimenter who kept an army of animals for physiological experiments—sometimes heard bitter epithets. As a matter of fact, Pavloff was an animal-lover, and was as proud of his fistulous dogs as a circus-master is of his trained walrus. Whenever any of his animals exhibited unusual intelligence, Pavloff never forgot to sing his praises. For instance, when Pavloff first began to make his pancreatic fistulæ, the abdominal wall of the animal became eroded by the escaping juice, and large bleeding patches appeared. In one of the dogs, the eroding effects of the juice became evident in two weeks, and the treatment employed yielded no good results. But one morning a heap of mortar was found beside the dog —which it had taken out of the laboratory wall. The annoyed attendants chained the animal elsewhere, but the next morning some more mortar was found torn from the wall. This time it was observed that the dog's belly was dry and the cutaneous irritation considerably reduced. The sagacious animal had cured itself by allowing the porous material to absorb the escaping juice. So a bed of sand was prepared for the animal, after which the flow of juice gave no more trouble, and the wall was no longer damaged. Pavloff and his associate Kuvschinski acknowledged with gratitude that the intelligence of the animal had helped them as well as itself. Pavloff said it would be a pity if this fact bearing upon the psychology of the dog were lost. Pavloff also had an esophagotomized dog which voluntarily took pebbles out of his hand and swallowed them; seeing the object in the early experiments, the obliging animal soon learnt to perform it of his own accord.

Pavloff urged all medical men to teach the public that animal experimentation is unavoidably necessary for the advancement of medicine, and of the greatest conceivable advantage to it:

> You who move about every day amongst the people, and come into intimate contact with the highest and lowest in the land, must make it understood that the greater the precision attained by experiments upon animals, the more certainly will patients be cured, and the less frequently will they have to submit to a trial of remedies, with possibly serious consequences. For instance, if more had been learned of the functions of the thyroid body by experiment upon animals, the early unhappy results of its removal from patients, the subjects of goitre, would not have occurred. There followed, as you know, an incurable condition of cretinism.

However, when Pavloff asks, "Do not nature and religion tell us that animals are provided for the service of mankind?"



На добрую память
И. П. Павлов
23 Июня
1923 г.

[SOLE AUTHORISED ENGLISH TRANSLATION]

THE WORK OF
THE DIGESTIVE GLANDS

Lectures by

PROFESSOR J. P. PAWLOW

DIRECTOR OF THE PHYSIOLOGICAL DEPARTMENT OF THE INSTITUTE FOR
EXPERIMENTAL MEDICINE, AND PROFESSOR IN THE IMPERIAL
MILITARY ACADEMY OF MEDICINE, ST. PETERSBURG;
FOREIGN ASSOCIATE OF THE ACADEMY OF
MEDICINE, PARIS; ETC. ETC.

TRANSLATED INTO ENGLISH
BY
W. H. THOMPSON, M.D., M.CH., F.R.C.S. (ENG.)

KING'S PROFESSOR OF THE INSTITUTES OF MEDICINE, TRINITY COLLEGE,
DUBLIN; LATE DUNVILLE PROFESSOR OF PHYSIOLOGY, QUEEN'S
COLLEGE, BELFAST; EXAMINER IN PHYSIOLOGY, ROYAL
UNIVERSITY OF IRELAND, AND ROYAL COLLEGES
OF PHYSICIANS AND SURGEONS, LONDON
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AUTOGRAPH OF PAVLOFF

we wish he would refer us to the chapter in the Book of Nature in which this statement occurs.

Some men work alone; others have co-workers. Pavloff was the Carl Ludwig of Russia: he was a teacher; he gathered pupils around him. In his writings, there are numerous references to his associates. Among the most successful of these students were Madam Schumova Simanovskaia, whom we have previously mentioned; Konovaloff, who showed that normal gastric juice is superior to any combination of commercial pepsin and hydrochloric acid found in the market; Khizhin, who collaborated in the work on the Pavloff pouch; Ketcher, who showed that the gastric juice, as it is poured out by the glands, always possesses a constant acidity; Glinski, who transplanted the orifices of the salivary glands upon the cutaneous surface, and demonstrated that the glands behave differently toward different foods—specific excitability; Mett, who devised a method for determining the proteolytic power of digestive fluids; Sokoloff, who studied the influence of different acids on the secretion of gastric juice; Lobasoff, who devised an ingenious method of feeding a fistulous dog without the animal's knowledge; Piontkovski, who found that when directly introduced into the duodenum, soap evokes an energetic secretion of gastric juice; Volkovitsch, who determined that fat has an inhibitory effect on the flow of gastric juice; Dolinski, who discovered that acids brought into contact with the mucous membrane of the duodenum, promptly cause a secretion of pancreatic juice; Damaskin, who studied the influence of fat on pancreatic juice; Gegaloff, who discovered the bile of carnivora contains a proteolytic ferment; Chepovalnikoff, who discovered the digestive importance of the succus entericus, and that it activates the pancreatic juice; Parastschuk, who found that the proteolytic ferment of the pylorus digestive juice requires hydrochloric acid to activate it; Walther; Arbekov; Bruno; Yurgens; Yablonski; and numerous others —certainly a group of pupils of whom any teacher might be proud. Without Pavloff and his pupils, the history of modern physiology could not be written.

In 1897, Pavloff published the investigations of his laboratory under the title *The Work of the Digestive Glands*—a classical monograph, which has the additional advantage of being interesting. It is safe to say that a medical student who fails to be stirred and fascinated by this volume, will never be an investigator. In 1904 the colleagues of Pavloff celebrated his twenty-fifth year of teaching. In that year the Nobel prize was given to him, and when the award was made known to the world, we hope there were not too many American physicians who asked, "Who is Pavloff?"

Fortunately for Pavloff, his fistulous dogs were able to absorb all his attention. Only a few paces from his laboratory, loomed the Fortress of Peter and Paul, within whose cold walls the noblest men and women in Russia were tortured to death because they dared raise a voice against the blood-thirst of the tsars. But the shadows of Siberia never fell athwart the path of Pavloff. Government officials planned and executed massacres, hanged children for reading a manifesto, butchered men and raped women for pastime, but Professor Pavloff was silent; he was a scholar, not a rebel. He was not of Sophia Perovskaya's breed, and Ossinsky's blood did not run in his veins. But our life is complex, and we need not only the stout arm that will free us from the tyranny of the House of Romanoff, but the clear brain that will free us from the tyranny of disease. And when we forget the "one long damning line of red, where exiles endless go," we may give full-hearted honor to one of the most illustrious of modern scientists—Ivan Petrovich Pavloff.

ADDENDUM

In the early part of the year in which Metchnikoff died, news came of the decease of another Russian scientist—Ivan Petrovich Pavloff. Within a few months the report was contradicted, but the incident gave rise to various estimates of Pavloff's work. Fielding H. Garrison in his History of Medicine (1921), lists the following: *"Boston M. & S. J., 1916, clxxiv, 799 (F. G. Benedict).—Brit. M. J., 1916, ii, 799 (W. M. Bayliss).—Med. Rev. of Rev., N. Y., 1916, xxii, 252–259 (V. Robinson).—Nature, Lond., 1916, xcvii, 9–11 (W. H. T.)."*

It was then said that the Pavloff who died was a court-physician of that name, and not the real Pavloff. In the period of the world-war and its aftermath, the rumors were various and conflicting, and from time to time the question was asked: "Is the great Pavloff still alive?" This uncertainty was answered, in the summer of 1923, by the announcement that Pavloff and his son, Professor Vladimir Pavloff, had arrived in New York.

America certainly knows how to entertain celebrated visitors. A pugilist, a prelate, an aviator or a diplomat, if only he has acquired fame, receives the keys of the city, and a roaring welcome emblazoned with newspaper headlines. When the royal feet of the queen of Rumania touched these shores, the whole country was prostrate; her journey was a triumphal progress across a continent; every newspaper from coast to coast grew hysterical with homage; nowhere in Europe did Marie arouse such obeisance as in democratic America. It is true that she was at the head of one of the most benighted governments of contemporary Europe; that her people were oppressed and deprived of human rights; that her prisons were overfilled with those who protested against mediæval tyranny in the twentieth century: these circumstances did not diminish one hosanna for the charming ruler of Rumania in the land of Washington. The Daughters of the American Revolution adore Queens.

What reception was accorded Pavloff in America? How did our country greet this benefactor of mankind? There was no official welcome at the City Hall, the reporters and photographers were occupied elsewhere, the physiological laboratories were practically closed for the summer, the professors were away on their vacations, yet the venerable scientist was not entirely neglected: as he sat in the train at Grand Central Terminal, three characteristic Americans warmly embraced him, and departed with his wallet containing all his funds. In this manner was the foreigner initiated into the mysteries of New York life. The gangster is indeed the most immune of American citizens. Had a similar experience befallen Welch or Flexner in Soviet Russia, how our press would have spewed forth venom in tons of printer's ink.

England was no more generous to Pavloff than America: attempting to get a British visa to his passport in order to attend the Congress of Physiologists at Edinburgh, he was informed that Bolsheviks were not permitted to enter the domain of Great Britain. It was explained that Pavloff, an eminent scientist of seventy-five, was not apt to hatch plots, that he was not a Bolshevik, in fact was an anti-Bolshevik—but have you ever tried to reason with a Consulate? Do you remember Byron's passport stanza in Don Juan, ending with the phrase, "the least civil sons of b—s"? Finally, after much humiliation, Pavloff was granted the visa, and according to the latest reports the British Empire has survived.

Soon after the arrival of the Pavloffs in America, it was our privilege to visit the pathfinder in his room at Hotel York. Thus we saw Pavloff—white-bearded, smiling, modest, with the childlike simplicity so characteristic of great Russians. As we stood before this man whom we had long revered and had mourned as dead, as we thought what Pavloff meant to experimental medicine, we realized we were in the presence of one of the immortals. He seemed like a figure from the past, holding physiology in his hand. We will never forget his graciousness at that meeting, nor his amused interest in our premature obituary.

The world has changed since it was written. In 1916, the Romanoffs seemed secure on the bloodiest throne in history: the following year the Romanoffs were prisoners of the revolution. In a Siberian cellar the House of Romanoff was exterminated, the tsar himself, with poetic justice, officially shot by a Jew. The face of Sophia Perovskaya now looks out of the Winter Palace, and the purple streak does not show around her youthful neck; a grand duke's mansion is turned into the Home of Scientists; and St. Petersburg has become Leningrad. Karl Marx, exile and outcast in his lifetime, is now the spiritual ruler of the vastest of realms. The future of Russia is veiled from human eyes. Socialists, with the word Comrade on their lips, yet hurling accusations at each other, continually wrangling over the brotherhood of man, are not the pleasantest individuals to have around. Russia, in chains for centuries, at last marches toward the sunrise of a new day. What lies beyond the horizon, none can foretell.

It was Coffinhall who remarked that his republic had no need of savants—and sent Lavoisier to the guillotine. The Soviets, far wiser, are the guardians of the arts and sciences: Russia to-day is the land of paradox, but nothing throughout the Socialist Republic is more amazing than its cultural enthusiasm and accomplishments. Pavloff, on the verge of eighty, is still the active director of the Institute of Experimental Medicine at Leningrad: many pupils carry on researches under his guidance, and the government publishes and distributes his studies. This son of the village priest, who has taught us so much about digestion and circulation and cerebral activity and conditional reflexes, labors under the Bolshevik banner as the dean of the world's physiologists. Régimes in Russia may change, but the experiments of Pavloff and his associates remain part of the eternal truths of science. We will never write another obituary notice of Ivan Petrovich Pavloff—long may it be before we read one!

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